LABORATORY PRACTICE

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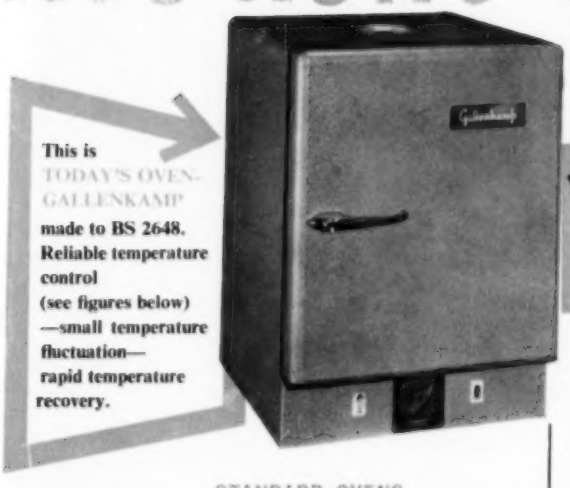
VOL. 9 No. 4 Published Monthly APRIL 1960

hot news

YESTERDAY'S LABORATORY OVENS ARE NOW STONE COLD!



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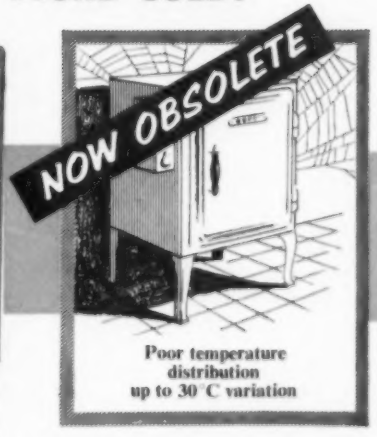

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Temp. fluctuation at 100°C ...	0.25	0.25	0.25
Spatial temp. variation at 100°C	±2·5	±2·5	±3
Temp. fluctuation at 200°C ...	0·3	0·3	0·3
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Incidental information

No.13

Items of interest from our laboratory notebooks

▶ Most analysts know about 1:10-phenanthroline and many use it for iron determinations. Not so many people seem to know that **4:7-diphenyl-1:10-phenanthroline** is twice as sensitive as 1:10-phenanthroline in the colorimetric determination of iron. There are several papers on the subject but the latest is *Analyst*, 1958, **83**, 80. The reagent is also called **Bathophenanthroline**, and we make it.

▶ Then again, the substitution of methyl groups in the 2:9 positions has the interesting effect of making the reagent insensitive to iron and we then have a selective and sensitive reagent for copper (see *Anal. Chem.*, 1956, **28**, 1158). Hopkin & Williams make **2:9-dimethyl-1:10-phenanthroline** (sometimes called **Neo-cuproin**).

▶ One does not think of sulphate as a radical one can determine absorptiometrically, but this is now possible for low concentrations. **Barium chloranilate** is the reagent and there are two papers on the subject — *Anal. Chem.*, 1957, **29**, 281 and *Anal. Chem.*, 1958, **30**, 202. Hopkin & Williams make it.

▶ Hopkin & Williams Ltd. were also early off the mark with supplies of the remarkable new colour-producing reagent for fluoride ions, **3-aminomethylalizarin-NN-diacetic acid**, described by Belcher, Leonard and West (*Talanta*, 1959, **2**, 92). This important reagent is already available from stock.

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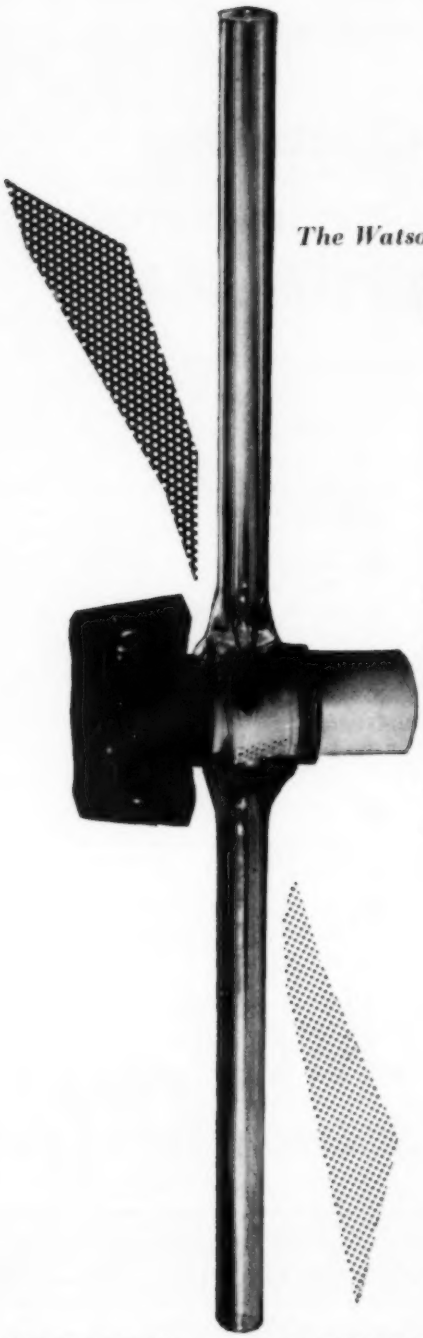

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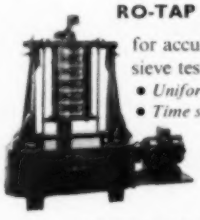

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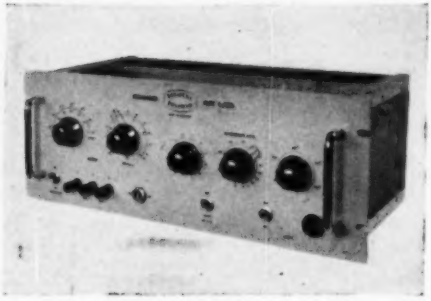

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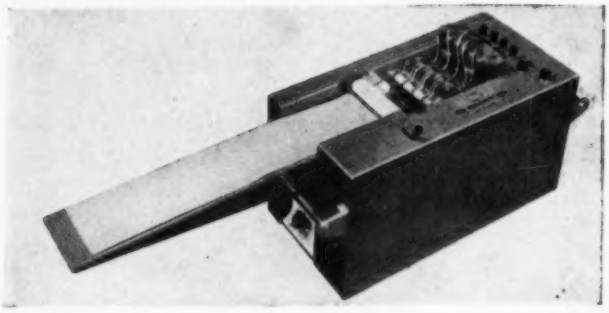

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The Siemans Ediswan pen oscillograph is a portable 1 to 4 channel, high speed, direct ink writing, recorder.
The pen motor coil is 1450 ohms centre tapped.
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Pen motors can be supplied with coil resistances of 230 ohms for use with trans/stors.
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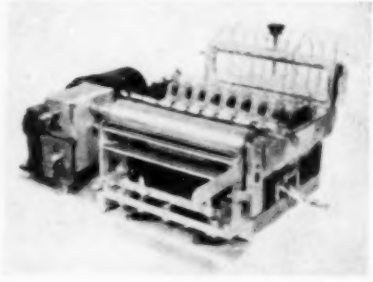

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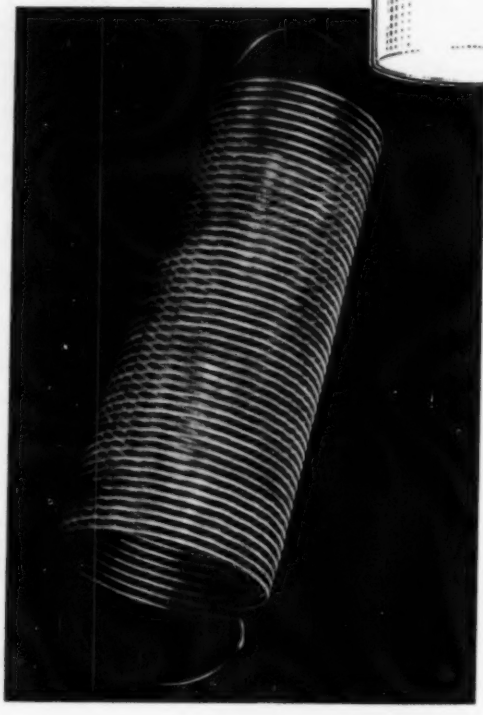

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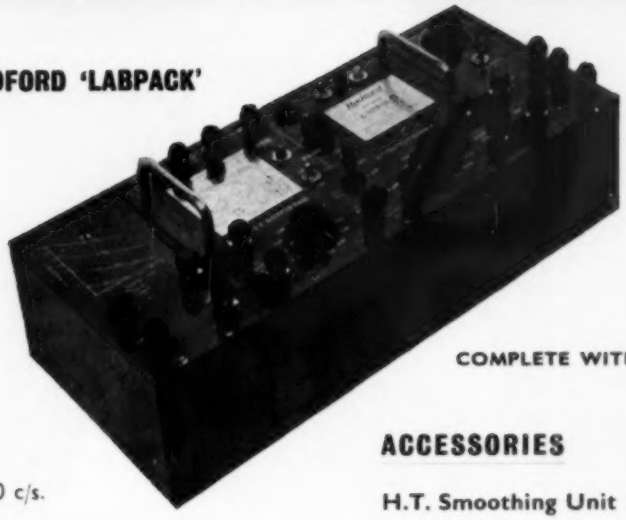

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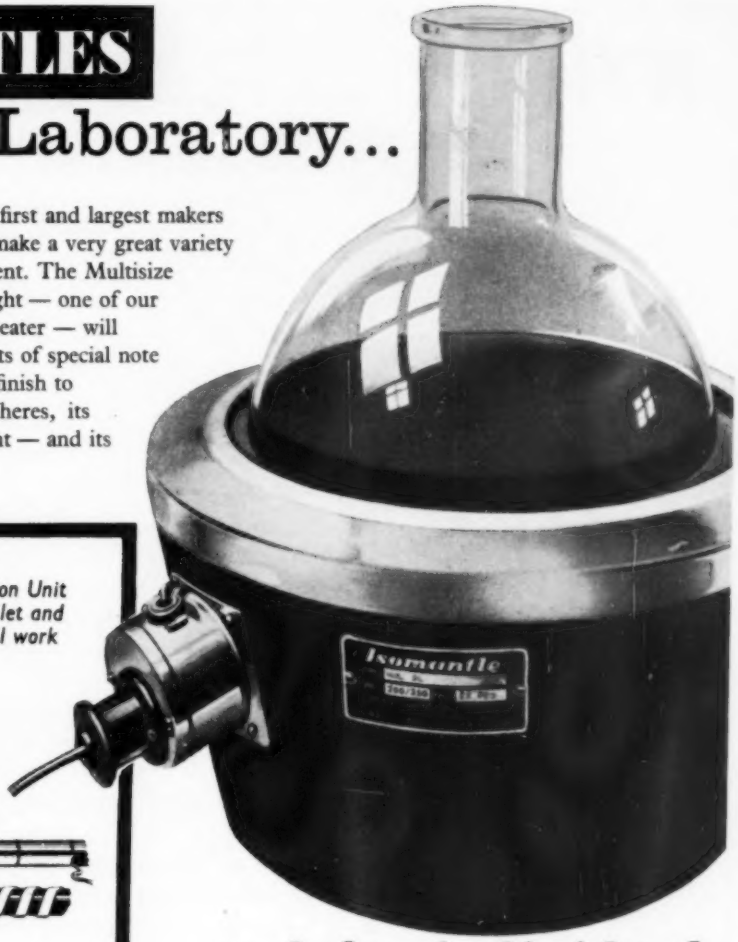

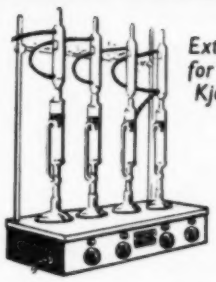

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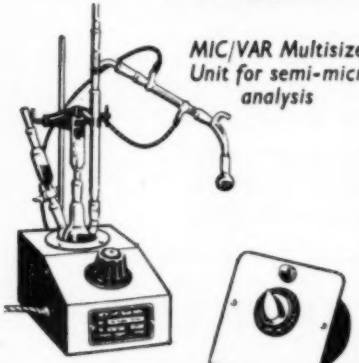

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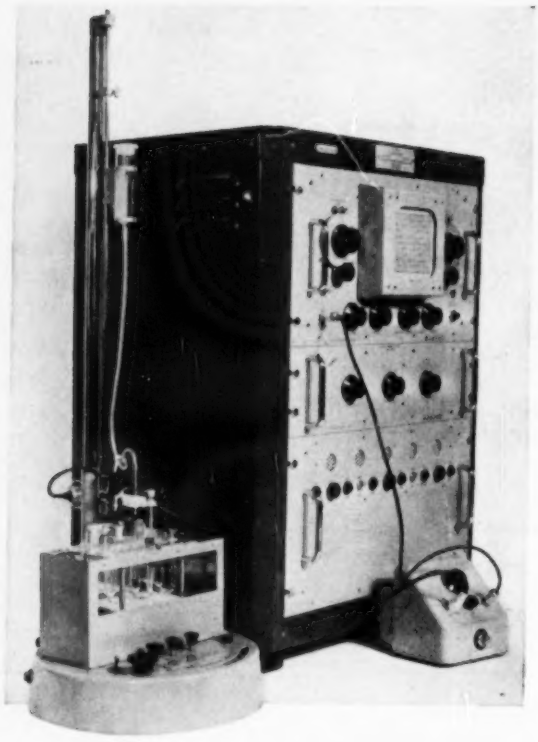

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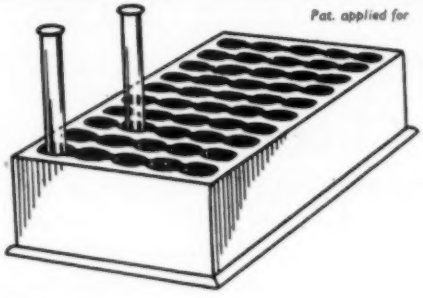

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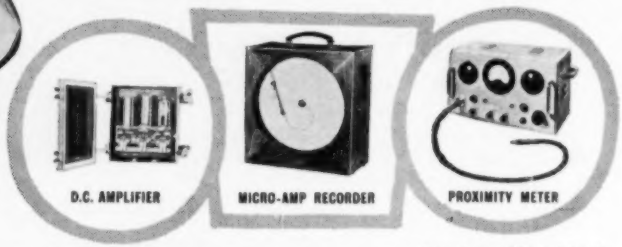

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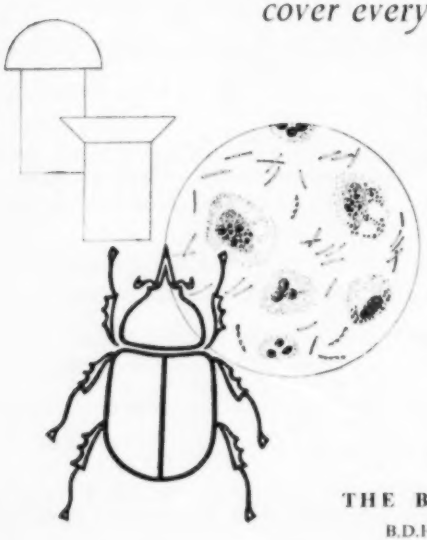

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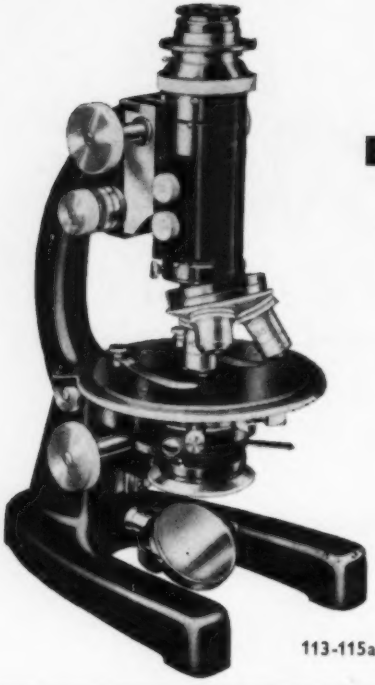

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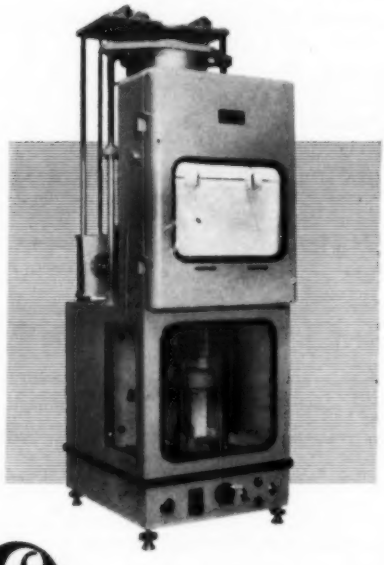

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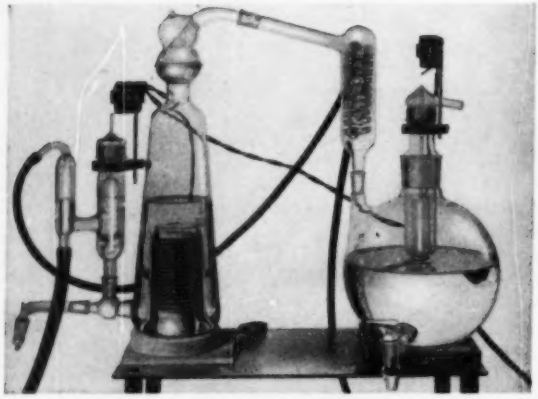

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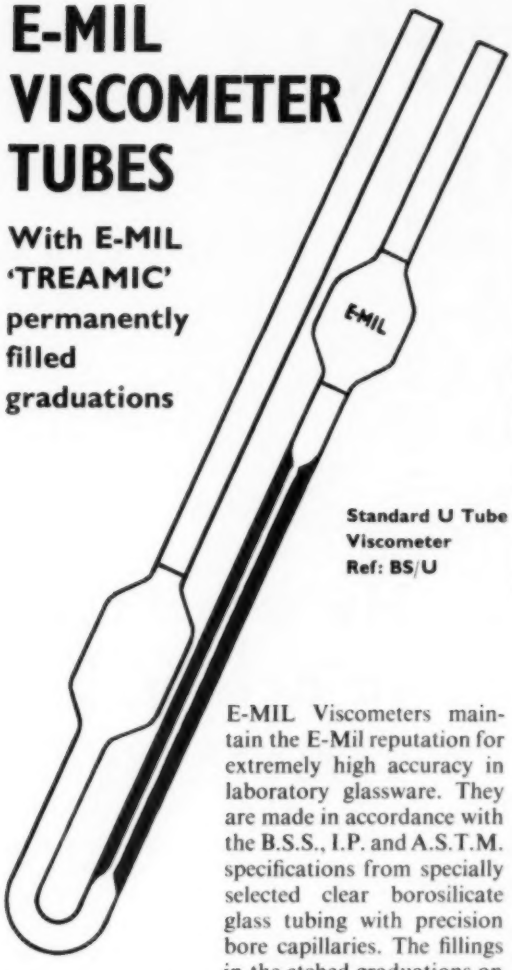

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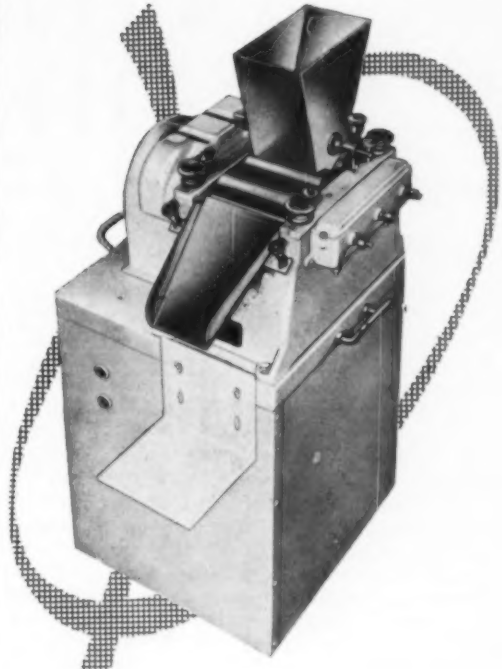

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EDITORIAL

Food Analysis and Food Legislation

THIS year is a land mark in the history of the scientific control of food. From the sixteenth century onwards various statutes had been passed dealing with the control of foods and beverages, but these were primarily concerned with revenue interests. Following various medical activities in the 1850's the Adulteration Act was passed in 1860. This Act and a subsequent one in 1872 made it an offence to adulterate foods. Although these Acts provided for analysts there were no standards for foods, and in those days analytical chemistry was very primitive as far as foods were concerned. Analysts, therefore, had to devise their own methods and set their own standards. It is not surprising that under such conditions little progress was made. The Food and Drugs Act of 1875 provided for the appointment of public analysts, and there have been further Acts of 1928 and 1955. Even today, however, the scientific aspects of our food laws are far from satisfactory. Few foods are defined, there are few standards and only rarely are official testing methods laid down. The control of food is shared by a number of authorities, including the Government which makes the laws, the local authorities whose duty it is to enforce them (by prosecution when necessary), the public analysts who are responsible for the testing and interpretation of the analytical results, and the courts which decide if a conviction is to be recorded.

The Food and Drugs Act itself does not in general include the few definitions and standards which have been made. These are usually set out in Regulations and Orders. One of the most important is the Labelling of Food Order, 1953 which is intended to protect the public from deception and fraudulent claims by food manufacturers. Most of the more advanced countries today have laws about food which are far more rigid and detailed than those in Britain. These frequently contain definitions and specify analytical methods, and this system makes it much easier for both the authorities and the analysts. Commercial interests are naturally reluctant to be controlled, but specific requirements at least have the advantage that all parties know where

they stand. If there is to be a regulation, it should preferably be clear above dispute.

If a standard is laid down it must obviously depend on one or more analytical methods. Analysis of food is a very tricky problem, and it is often impossible to determine the desired constituent directly. For example, such constituents as moisture, fat, ash, protein (as nitrogen), various minerals, trace elements and vitamins can usually be determined with a fair degree of accuracy, and reproducibility between laboratories is good. On the other hand, more general constituents such as fruit contents, milk solids-not-fat and other natural ingredients of compounded foods often cannot be determined with accuracy, and the more numerous the ingredients of the food the more difficult does analysis become. Further, these are the ingredients in which the consumer is most interested. Although in practice all analysts concerned—public analysts, food scientists and Government Chemist's staff—use much the same methods, any public analyst acting for a local authority is entitled to use his own method and to attach his own interpretation to the results he obtains. Other countries such as U.S.A., Canada and some in Western Europe not only have exact definitions of foods in analytical terms but have official methods which can be followed by all parties concerned. The official methods of the Association of Official Agricultural Chemists in U.S.A. constitute an excellent example of this system. Even if the official method is not the latest or best, there is at least uniformity in the examination of the food. With a few exceptions in this country we have no such official methods. The former Society of Public Analysts did excellent work in publishing many good methods for some foods, but these are not official methods although they are frequently used. A disadvantage we suffer from in Britain is a multiplicity of scientific bodies, especially in chemistry. Thus we have the Chemical Society, the Society of Chemical Industry, the Royal Institute of Chemistry, the Society for Analytical Chemistry, as well as a large number of societies (mainly chemists) devoted to one field or interest. One result of this diversity of organization is that it has been left to the British Standards Institution to attempt the standardization of analytical methods for foods and other materials. The B.S.I. originated from engineering activities, but all its analytical committees consist mainly of chemists. If there had been one chemical organization, with appropriate sub-divisions, analytical methods for all materials could have been standardized long ago, and chemists would not be paying a multiplicity of subscriptions. A chemist who takes his work seriously today can easily pay about £30 annually in subscriptions, and in spite of this we are still without standard methods, and chemists are dependent on an outside organization for the establishment of methods which are gradually becoming recognized as standard methods.

Standards for foods may give consideration to several aspects, such as contents of natural ingredients, e.g. orange juice and milk solids-not-fat, nutritive values based on protein, minerals and vitamin contents, absence of cheap substitutes, and absence of harmful additives. Our few standards are, strangely enough, largely concerned with those qualities which cannot be accurately assessed. Typical examples are the fruit contents of squashes, the meat content of sausages, and the milk solids-not-fat content of ice cream. A more satisfactory approach to the scientific control of foods would have been one based on those properties which can be measured with some reasonable degree of accuracy in the laboratory. There are many which are of great nutritive importance, and emphasis on these in the initial stages would have been more rewarding. Considerable attention is sometimes paid to whether a particular ingredient, e.g. a specified fat, is genuine or not. It is often difficult to be precise on this sort of problem, and there is really no nutritive advantage under consideration because all natural fats have much the same nutritive value, apart from certain properties of therapeutic interest which can be easily assessed.

To sum up, it would be more satisfactory to frame food control legislation on those properties which can be measured, and which are of nutritional significance.

The Labelling of Food Order in some ways is legislation in advance of our scientific knowledge. It is doubtful if we know enough of the requirements of humans for vitamins and minerals to lay down precise limits as to how a food can be assessed in respect of its value in vitamins, minerals and trace elements. It would be simpler and safer merely to require all compounded foods to bear a label stating the absolute contents of its ingredients, e.g. casein, soya flour, maize oil, and also the absolute contents of its added 'chemical' constituents, e.g. phosphates, citric acid, glucose, vitamins, minerals and trace elements. These can usually be determined in the laboratory, and the consumer can take advice as to the value of any compounded food. Attempts to control advertising claims to prevent deception of the public are laudable, but often fail because a competent food scientist can usually so frame an advertisement that a statement can be true scientifically but misleading to the general public.

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Rosenhain Medal for 1960 to Prof. Norman James Petch (William Cochrane Professor of Metallurgy, King's College, University of Durham) in recognition of his outstanding contributions in the field of physical metallurgy.

W. H. A. Robertson Medal and Premium for 1959 to Dr. Maurice Cook and Mr. E. Swainson (formerly Chairman and Assistant Manager, Technical Department, respectively, Imperial Chemical Industries, Ltd., Metals Division, Witton, Birmingham) for a paper on 'Arc Melting of Reactive and Refractory Metals', published in the Journal of the Institute of Metals, 1958-59, Vol. 87, pp. 161-173.

SELECTIVE MEDIA FOR THE ISOLATION AND ENUMERATION OF LACTOBACILLI

by M. Elisabeth Sharpe

National Institute for Research in Dairying, University of Reading

THE isolation and enumeration of lactobacilli are of increasing importance as the significance and interrelationships of these and other micro-organisms in many diverse natural habitats are investigated. It has been of particular interest to isolate them selectively from such sources as the intestine of man and animals, from saliva, milk and dairy products, silage, grass, spoiled beer and wines, and certain fermentation products, and the difficulty of isolating lactobacilli from such sources, where they may occur among large populations of much less fastidious organisms, has been recognized for many years. Taking into account the high acid tolerance of lactobacilli, early investigators (McIntosh, James and Lazarus-Barlow, 1922) used nutrient broth media at a low pH, often acidified with acetic acid, to suppress the growth of other organisms. Such media were not satisfactory, however, as their poor nutritional qualities allowed only a proportion of the lactobacilli present to develop. Tomato juice media, used by later workers, gave a better growth of lactobacilli, but were not entirely selective, even at an acid pH, as yeasts, moulds and streptococci were liable to grow and sometimes to outgrow the lactobacilli. The addition of thallous acetate to such tomato juice media, while suppressing organisms other than lactic acid bacteria (Sharpe, 1955) still allowed the streptococci to grow. Recently, several more highly selective media for lactobacilli have been developed, some of which have been used for isolations from many different sources, and others which have had a more limited application.

Selective Acetate Media

The most widely used selective media are all based on the use of a low pH, a high concentration of acetate ions and the addition of oleate in the form of Tween 80, a sorbitan mono-oleate polyoxyalkylene derivative. The acetate is inhibitory to other organisms, but does not adversely affect the growth of lactobacilli; it has, in fact, been shown (Guirard, Snell and Williams, 1946) to stimulate the growth of some strains. The Tween 80 markedly stimulates the growth of lactobacilli. Such media were first described by Keddie (1951) in this country, and Rogosa, Mitchell and Wiseman (1951a, b) in the United States. Working independently, both published formulae for selective agar media which they used for the isolation and counting of lactobacilli from natural habitats.

Keddie's medium contained peptone, meat extract, tomato juice, yeast extract, glucose, agar, Tween 80 and 0·2 molar acetic acid/sodium acetate buffer. The concentrated buffer was sterilized separately and added, just before use, to the rest of the medium which had been previously sterilized with the pH adjusted to 5·4. This was found to be a satisfactory medium for isolating and counting the lactobacilli from grasses and silage, where they may occur in only small numbers and be greatly outnumbered by other organisms, such as streptococci, sporeformers and *Klebsiella*.

An adaptation of Keddie's medium was used by Leesment (1955) in Sweden, who substituted carrot juice for tomato juice and added manganese to the medium. He was able to isolate lactobacilli from Herrgard cheese in the earliest stages of ripening, when they occur in small numbers and many streptococci are present.

Rogosa, Mitchell and Wiseman's medium differed from Keddie's in that it contained trypticase, a tryptic digest of casein, and not tomato juice or meat extract. Manganese, magnesium and iron salts and also citrate and phosphate were added (Table I). However, the essential factors of pH 5·4, and the presence of acetate and Tween 80 were the same. The presence of manganese is important, especially in conjunction with the correct citrate balance (Evans and Niven, 1951), as many lactobacilli, particularly the homofermentative low

TABLE I

Comparison of Rogosa and Modified Rogosa Media (after Mattick and Mabbitt, 1956)

Ingredients	*Modified Rogosa Medium*	*Rogosa Medium*
Trypticase B.B.L.		10·9 g.
Tryptic milk digest	890 ml.	
Yeast extract	6·0 g.	5·47 g.
KH_2PO_4	7·2 g.	6·55 g.
$(NH_4)_2H$ citrate	2·4 g.	2·18 g.
Salts solution	6 ml.	5·47 ml.
Glucose	24·0 g.	21·8 g.
Tween 80	1·2 g.	1·09 g.
$NaAc3H_2O$ } HAc }	0·24 M	0·225M
Agar	20·4 g.	16·4 g.
Water to	1092 ml.	1092 ml.

temperature ones and also the heterofermentative ones, are greatly stimulated by the addition of manganese (Orla Jensen, 1943). Rogosa *et al.* (1951b) compared the growth of a large number of pure cultures of lactobacilli, representing many different species, in tomato juice agar and in their selective agar. They found that the numbers of lactobacilli were comparable, but the size and rate of development of the colonies were often greater in the selective medium. This medium was then used successfully for the isolation and enumeration of lactobacilli from the saliva of man and hamsters, from the faeces of hamsters, and from the human vagina. Lactobacilli were isolated in numbers comparable with, or much greater than those isolated on tomato juice agar, and with the complete elimination of micrococci, streptococci, moulds, sporeformers and Gram-negative rods. Except for the infrequent presence of certain yeasts in small numbers, the medium was completely specific. It is now widely used in the United States for the study of lactobacilli in saliva, and their role in dental caries. It has also been found valuable for investigations of lactobacillus populations of the intestine of the chick (Wiseman, Sarles, Benton, Harper and Elvehjem, 1956) and the pig (Larson and Hill, 1955), and for isolations of oral and intestinal strains from the rat (Rogosa, personal communication). When used as a broth, in serial dilutions, Jensen, Smith, Edmondson and Merilan (1956) found it useful for isolating lactobacilli from rumen fluid. Lactobacilli have also been isolated from milk and sour cream containing very small numbers of these organisms (Jensen and Edmondson, 1957) and from raw and pasteurized milk, including milks con-

Fig. 1. Numbers of lactobacilli and streptococci present in a Cheddar cheese (after Mabbitt and Zielinska).

taining numerous other bacteria (Johns and Cole, 1959). The latter authors also enumerated the lactobacilli in Cheddar cheeses over the ripening period, and were able to trace their growth in the cheese from two days to 12 months.

Mabbitt and Zielinska (1956) described a modification of Rogosa's medium which they used for enumerating the lactobacillus flora of Cheddar cheese. They found it invaluable for studying the growth of lactobacilli in the early stages of cheese ripening, when very large numbers of starter streptococci are still present in the cheese, and the numbers of lactobacilli are extremely small. Fig. 1 shows the development of lactobacilli in a cheese, in the presence of starter streptococci. The starter streptococci were counted on a tomato juice agar, and the lactobacilli on Mabbitt and Zielinska's medium.

Naylor and Sharpe (1958a, b), studying the role of lactobacilli in the production of flavour in Cheddar cheese, confirmed the value of the Mabbitt and Zielinska medium for isolating lactobacilli in the early stages of cheese ripening. Fig. 2 shows that when they compared the proportions of starter streptococci and lactobacilli isolated from triplicate borings of Cheddar cheese in three different media, during the ripening period of the cheese, the selective acetate medium was far superior to the other media for enumerating lactobacilli. On the selective acetate medium it was possible to isolate lactobacilli as early

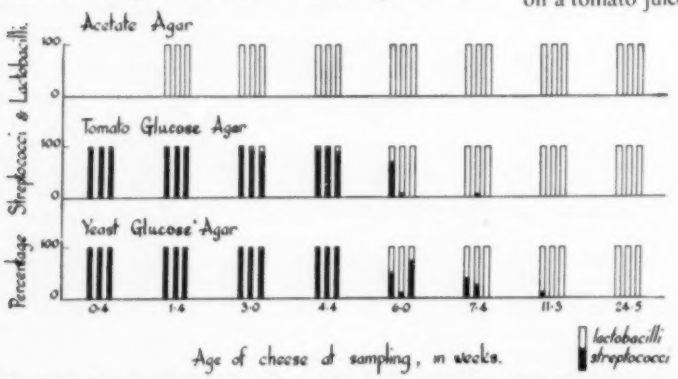

Fig. 2. Relative numbers of starter streptococci and lactobacilli isolated from triplicate borings on three media during the ripening period of a cheese, when picking 20 colonies from the highest countable dilution on each medium (after Naylor and Sharpe).

as 1·4 weeks, no starter streptococci being found. On the tomato juice medium lactobacilli were not isolated in large numbers until the cheese was six weeks old as streptococci occurred in large numbers. Yeast glucose agar, a general purpose medium, was even more favourable to the starter streptococci.

Table I shows a comparison of the formulae of the Rogosa medium and the Mabbitt and Zielinska medium (Mattick and Mabbitt, 1956). The modifications consisted of substituting a tryptic digest of skim milk for the tryptic casein digest used by Rogosa, and of increasing the final concentration of other ingredients by 10 per cent. As it was intended to use this medium primarily for isolating lactobacilli from cheese, it was considered that the whole milk would have better nutritional properties than casein digest for some dairy lactobacilli.

Mabbitt and Zielinska compared their medium with Keddie's medium and found that it gave a better growth of *Lactobacillus casei* and *L. plantarum*. Leesment (1956) confirmed this, using a greater number of strains. Naylor (1956) compared the growth of several type strains of 11 different species of lactobacilli in pure culture on tomato juice media and on Mabbitt and Zielinska's medium, using both broth and agar. Most of the species grew much better in the Mabbitt and Zielinska broth (which has the same formula but with the agar omitted) than in tomato juice broth. The selective acetate agar gave comparable counts with the tomato juice agar for low temperature homofermentative lactobacilli and for the heterofermentative lactobacilli, but with some of the high temperature homofermentative lactobacilli counts were slightly lower on the selective acetate medium. As this acetate medium of Mabbitt and Zielinska was designed particularly for work with the low temperature homofermentative and heterofermentative lactobacilli, such as occur in Cheddar cheese, this medium was considered satisfactory for such work, particularly in view of the marked stimulation of many of the organisms when grown in it. Naylor also compared Rogosa's agar with Mabbitt and Zielinska's agar and found the counts were alike in all cases, and that the two media were very similar. Rogosa *et al.* emphasized that the citrate-salts relationship was important and suggested that their medium might need modifying for thermophilic dairy lactobacilli, such as *L. lactis* or *L. helveticus*.

Mabbitt and Zielinska's medium has found many applications, for the isolation of lactobacilli from dairy products: Perry and Sharpe (1960) were able to isolate lactobacilli from raw milks when these organisms were present in very small numbers of less than 1 per ml. of milk; Sharpe *et al.* (1958) isolated lactobacilli as contaminants from cheese starter cultures containing millions of vigorously growing lactic streptococci. Nichols, Sharpe and Naylor (unpublished data) used this medium as an aid to eradicate an outbreak of rusty spot in the cheese of a dairy manufacturing Cheshire cheese. The discoloration was found to be due to the growth of an orange-red pigmented strain of *L. plantarum*. Using the selective medium, the source of the infection was discovered, in spite of the large numbers of other organisms present in the dairy and its environments, and the organism was eliminated. Acetate broth was particularly useful here for enrichment, as the presence of the spoilage organism was denoted by a deep red coloured growth in the bottom of the tubes of broth.

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Neither Rogosa *et al.* nor Mabbitt and Zielinska sterilized their media before use, although in each case the ingredients were heated at some stage in their preparation. The inhibitory effect was sufficient to render further sterilization unnecessary, if the media were dispensed hot into screw-capped bottles. After storage in the refrigerator for at least six months, they remained free from contamination. Prolonged or repeated heating darkened them and also diminished the growth of some strains of lactobacilli. The pH was critical: at pH 5·6 lactic streptococci would also grow, while at pH 5·2 the growth of some strains of lactobacilli was retarded.

For the isolation of lactobacilli from natural sources, plates of these selective media should be incubated for three days at 37° C. or five days at 30° C., the temperature of incubation depending on the habitat. It is preferable to incubate plates in anaerobic jars under an atmosphere of 95 per cent hydrogen or nitrogen + 5 per cent CO_2, (without sparking the jar). Not only does this prevent evaporation, and give the semi-anaerobic conditions preferred by lactobacilli, but the CO_2 has a stimulatory effect on their growth. If, however, the plates have to be incubated aerobically, double layer plates of selective medium should be used, to give the semi-anaerobic conditions, and to prevent evaporation.

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temperature ones and also the heterofermentative ones, are greatly stimulated by the addition of manganese (Orla Jensen, 1943). Rogosa *et al.* (1951b) compared the growth of a large number of pure cultures of lactobacilli, representing many different species, in tomato juice agar and in their selective agar. They found that the numbers of lactobacilli were comparable, but the size and rate of development of the colonies were often greater in the selective medium. This medium was then used successfully for the isolation and enumeration of lactobacilli from the saliva of man and hamsters, from the faeces of hamsters, and from the human vagina. Lactobacilli were isolated in numbers comparable with, or much greater than those isolated on tomato juice agar, and with the complete elimination of micrococci, streptococci, moulds, sporeformers and Gram-negative rods. Except for the infrequent presence of certain yeasts in small numbers, the medium was completely specific. It is now widely used in the United States for the study of lactobacilli in saliva, and their role in dental caries. It has also been found valuable for investigations of lactobacillus populations of the intestine of the chick (Wiseman, Sarles, Benton, Harper and Elvehjem, 1956) and the pig (Larson and Hill, 1955), and for isolations of oral and intestinal strains from the rat (Rogosa, personal communication). When used as a broth, in serial dilutions, Jensen, Smith, Edmondson and Merilan (1956) found it useful for isolating lactobacilli from rumen fluid. Lactobacilli have also been isolated from milk and sour cream containing very small numbers of these organisms (Jensen and Edmondson, 1957) and from raw and pasteurized milk, including milks containing numerous other bacteria (Johns and Cole, 1959). The latter authors also enumerated the lactobacilli in Cheddar cheeses over the ripening period, and were able to trace their growth in the cheese from two days to 12 months.

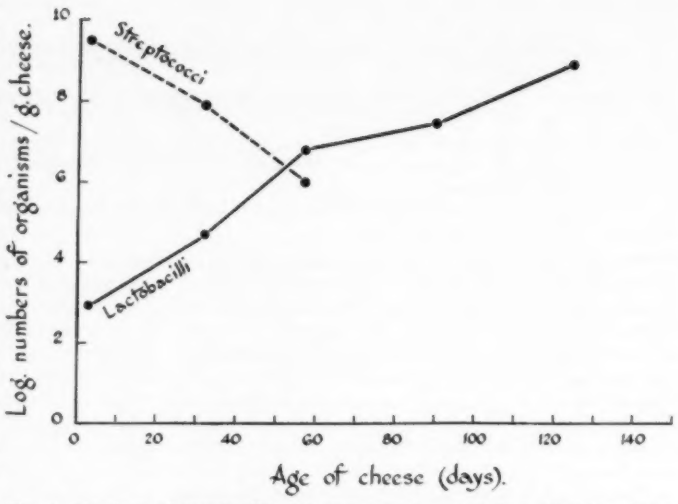

Fig. 1. Numbers of lactobacilli and streptococci present in a Cheddar cheese (after Mabbitt and Zielinska).

Mabbitt and Zielinska (1956) described a modification of Rogosa's medium which they used for enumerating the lactobacillus flora of Cheddar cheese. They found it invaluable for studying the growth of lactobacilli in the early stages of cheese ripening, when very large numbers of starter streptococci are still present in the cheese, and the numbers of lactobacilli are extremely small. Fig. 1 shows the development of lactobacilli in a cheese, in the presence of starter streptococci. The starter streptococci were counted on a tomato juice agar, and the lactobacilli on Mabbitt and Zielinska's medium.

Naylor and Sharpe (1958a, b), studying the role of lactobacilli in the production of flavour in Cheddar cheese, confirmed the value of the Mabbitt and Zielinska medium for isolating lactobacilli in the early stages of cheese ripening. Fig. 2 shows that when they compared the proportions of starter streptococci and lactobacilli isolated from triplicate borings of Cheddar cheese in three different media, during the ripening period of the cheese, the selective acetate medium was far superior to the other media for enumerating lactobacilli. On the selective acetate medium it was possible to isolate lactobacilli as early

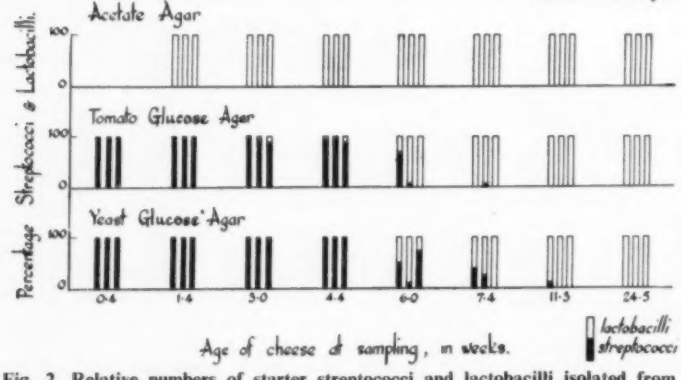

Fig. 2. Relative numbers of starter streptococci and lactobacilli isolated from triplicate borings on three media during the ripening period of a cheese, when picking 20 colonies from the highest countable dilution on each medium (after Naylor and Sharpe).

as 1·4 weeks, no starter streptococci being found. On the tomato juice medium lactobacilli were not isolated in large numbers until the cheese was six weeks old as streptococci occurred in large numbers. Yeast glucose agar, a general purpose medium, was even more favourable to the starter streptococci.

Table I shows a comparison of the formulae of the Rogosa medium and the Mabbitt and Zielinska medium (Mattick and Mabbitt, 1956). The modifications consisted of substituting a tryptic digest of skim milk for the tryptic casein digest used by Rogosa, and of increasing the final concentration of other ingredients by 10 per cent. As it was intended to use this medium primarily for isolating lactobacilli from cheese, it was considered that the whole milk would have better nutritional properties than casein digest for some dairy lactobacilli.

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these so-called micrococci were probably pediococci; Gibson, Stirling, Keddie and Rosenberger (1958) have now reported the isolation of pediococci from silage on the Keddie medium, and some of Mabbitt and Zielinska's strains have been identified by Dr. E. I. Garvie (private communication) as *Pediococcus cerevisiae*. Naylor and Sharpe (1958b) and Perry and Sharpe (1960) have since also isolated leuconostocs and *P. cerevisiae* from raw milk and from Cheddar cheese when using Mabbitt and Zielinska's medium. It is likely that previous workers who have reported the presence of micrococci in ripening cheese were on some occasions isolating pediococci. As Dacre (1958), who also isolated pediococci from Cheddar cheese has pointed out, these organisms may have a much more varied habitat than previously supposed.

Attempts to suppress the pediococci and leuconostocs on the selective media have not met with success. Raising the acetate or sodium chloride concentration (Mabbitt and Zielinska, 1956; Leesment, 1956), addition of thallous acetate (Leesment, 1956), or dinitrophenol or thioglycollic acid (Beech and Carr, 1955; Leesment, 1955) did not inhibit the pediococci at all, and only partially suppressed the leuconostocs. One may suppose that their metabolic pathways are to some extent similar to those of the lactobacilli. As these other organisms may occur on the selective media when isolating from some habitats, confirmation of the identity of the organisms developing on such media will be required by picking colonies for microscopic identification.

Selective Media for Aciduric Conditions

Other methods of selectively isolating lactobacilli by differential media have been employed in the brewing and cider making industry. Here it is necessary to suppress such aciduric organisms as yeasts, moulds, *Acetobacter*, *Flavobacterium proteus*, leuconostocs and pediococci, and a number of inhibitory chemical compounds and antibiotics have been found useful. Strandskov, Brescia and Bockelmann (1953), investigating media which would be selective for lactobacilli from brewer's yeast, found that the addition of some phenyl alcohols and phenols, such as phenyl ethyl alcohol, to a basal glucose yeast medium, suppressed the growth of the Gram-negative bacteria and the yeasts and allowed only lactobacilli and pediococci to grow. Alternatively, the addition to the basal medium of Actidione to suppress the yeasts, and of Polymixin B to suppress Gram-negative bacteria and pediococci, resulted in even greater selectivity, as the pediococci were also inhibited. Williamson (1959), also working on the control of contaminants of brewer's yeasts, found that the basal media in use for selectively isolating lactobacilli did not give adequate growth of all strains of lactobacilli examined. He devised a medium containing liver extract, maltose, casein hydrolysate and boiled unhopped beer, which gave a much more profuse growth of lactobacilli than the media previously used. Actidione (10 μg./ml.) was added to suppress the yeasts, and Polymixin B (10 μg./ml.) to suppress *F. proteus*. *Acetobacter* was found to be relatively resistant to Polymixin B, but was almost completely inhibited on this medium by incubating plates in an atmosphere of CO_2, and by raising the pH of the medium from 5·5 to just over 6·0. Phenyl ethyl alcohol (0·3 per cent) was of some value, but considerably reduced the counts of some strains of lactobacilli.

In their detailed survey of inhibitory compounds for the isolation of yeasts and bacteria found in apple juices and cider, Beech and Carr (1955), using a collection of type strains of yeasts, lactic acid bacteria and *Acetobacter*, examined a wide variety of organic chemical compounds and antibiotics. The basal medium was a wort agar at pH 5·4; selective media for lactic acid bacteria were tested anaerobically under CO_2. It was found that only sorbic acid (2,000 ppm) inhibited the acetic acid bacteria and did not affect the growth of the lactic acid bacteria, and also, in conjunction with Actidione (50 ppm) and dehydroacetic acid (250 ppm) suppressed the yeasts present. 2 : 4 dinitrophenol suppressed the streptococci tested (leuconostocs and *Str. cremoris*) while allowing the lactobacilli (*L. brevis*, *L. buchneri*, *L. fermenti*, *L. hilgardii*, *L. casei*, *L. plantarum* and *L. leichmannii*) to grow. The compound O-phenyl phenol would have been useful in distinguishing the streptococci from the lactobacilli, except that *L. mesenteroides* was not inhibited, while *L. casei* was. The heterofermentative lactobacilli were more resistant than the homofermentative species to the action of the test substances.

A number of selective media for lactobacilli are now available. The choice of medium must be determined by the environment from which isolations are to be made. A medium containing Actidione is extremely useful for suppressing brewery yeasts, but yeasts from other sources may not be quite so sensitive to this compound (Beech and Carr, 1955). The acetate media, so valuable for isolating lactobacilli from a wide variety of animal, dairy and plant sources, might be less satisfactory for the examination of fermentation products in such instances where an aciduric flora is present and where the lactobacilli may have somewhat different nutritional requirements from the more commonly encountered species. The importance of an adequate nutritional medium for selective isolation must be emphasized. A differential medium is likely to contain substances or conditions (such as pH) which do not encourage optimum growth, and may be on the threshold of inhibition even for the organisms to be selected. The combination of such conditions with a nutritionally unbalanced or inadequatemedium would result in suppression of the more fastidious species of the very organisms to be isolated. A basal medium giving vigorous growth of the organisms to be selected is essential. This condition is particularly well fulfilled by the acetate media, where Keddie, Rogosa *et al.* and Mabbitt and Zielinska all observed a much better development of

colonies of lactobacilli in their media than on the various tomato juice media commonly used for culturing lactobacilli.

Such points as these must be considered before choosing the most suitable selective medium, particularly in any new field of investigation.

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CORRESPONDENCE

David and Goliath

To the Editor,

Laboratory Practice.

DEAR SIR,—The interesting article, under the above title, in the February issue of your journal, considers the structure of the laboratory furnishing industry as seen from the user's point of view. The writer of the article gives the impression that a number of small businesses (giving a restricted, but very personal service) are overtowered by some gigantic organizations (reasonably efficient, but soulless.) How near to reality is this picture? The industry is at present headed by some five companies each employing between one hundred and six hundred people on its laboratory furnishing activities, i.e. excluding manufacture; the remaining firms are all smaller in size. To call the first group 'giant companies' seems strange, judged by present-day industrial and commercial standards. This all the more true if it is realized that, as in the case of my company, the staff are divided between a number of autonomous branches, each having its own local management, carrying comprehensive stocks and providing a full sales service: personal contact is further strengthened by making both inside sales staff and outside representatives responsible for limited areas, so that, to them, customers are not merely 'names, but distinct human beings.' This process of decentralization even reaches the level of van drivers who, by serving regularly the same district, can make their own contribution in this matter of customer relations. If it can thus be refuted that the larger company is capable of providing a service with a personal touch, what additional reasons are there for its existence? Your article rightly mentions comprehensive catalogues, large stocks, development and technical departments: in short, the kind of service which a mere middleman can normally not provide and which, therefore, is frequently also of considerable indirect value to the smaller competitor.

But surely the whole problem needs to be considered from a wider economic angle? The industry is one where overhead expenditure is both heavy and, to a large extent, of a 'fixed' nature, that is to say, much of the expenditure does not vary with the volume of business transacted, but arises from the very nature of the trade: for instance, a multitude of items (several tens of thousands) to be handled, high investment in, and slow turnover of, stock (only three to four times a year), comparatively low value of individual orders, technical nature of products requiring qualified staff, high cost of technical literature, catalogues and transport, etc., etc. Whilst the smaller man, having been forewarned, might score by stocking for a certain customer a 'somewhat unusual size or type of flask', the large number of laboratories in education, industry and research (and be it noted, not only at home, but in widely spread export markets) are far more exacting in their requirements. They expect from their supply houses not only a prompt but a comprehensive service. A high degree of internal organization and efficiency has, therefore, to be achieved, calling for the use of modern techniques, such as stock control, work study, improved packing methods and suchlike. The success of this work is reflected in the fact that nowadays it need no longer be a question of being 'lucky enough to get an off-the-shelf delivery', since, for instance, in my own company, between 85 per cent to 90 per cent of all catalogue items are supplied from stock. It is obvious that running costs of such magnitude can only be borne if they are matched by a correspondingly large volume of business. In the long run customers will benefit not only from a high standard of service, but also from a more competitive price structure resulting from large scale forward buying and producing.

I am of the opinion that, like other industries, laboratory furnishers (in common with their customers)

will be unable to disregard the pressure of stark economic facts: if they are to retain their place as the major supply source for all apparatus and equipment used by laboratories (which, in our electronic age, requires an approach different from the former 'beaker and flask' mentality), then they are bound to muster their forces in a manner adequate to the task and worthy of the contribution they can make to the advancement of scientific endeavour.

Yours faithfully,

H. C. MAYER,
Director & Secretary
Griffin & George Ltd.

Ealing Road,
Alperton,
Wembley, Middlesex.

To the Editor,

Laboratory Practice.

DEAR SIR,—Although your article 'David and Goliath' published in the February, 1960 issue of *Laboratory Practice*, is a fair summary of the situation in the laboratory furnishing trade, I feel that there has been an over-simplication of the issues involved.

In the first place, the choice does not necessarily lie between a village grocer type of laboratory furnisher on the one hand and a giant combine on the other. The very small type of firm with perhaps only three or four employees can, of course, only give a service over a very limited range and cannot hope to give the sort of service required by a modern laboratory.

There are, however, quite a number of 'flourishing Davids' of which my company is only one, with efficient organization, staff say between 25 and 80, publishing comprehensive catalogues who can and do satisfy the requirements of any size laboratory. These are the ones whom I will refer to as smaller companies in my comments.

Up to the present the take-overs and amalgamations of the larger companies, which started in a minor way some ten years ago and has accelerated in the last five years has had nothing but a beneficial effect on these smaller companies if they are efficient.

To take my own company as a typical example, during the first 30 years (1918-1948) of our existence, the average annual increase in the volume of sales, after allowing for price increases was 4 per cent.

In the last four years, however, during the era of take-overs, the average annual rise has been 27 per cent. This I feel, is the clear answer that the intelligent buyer of laboratory apparatus has given to the appearance of giants.

However, the implications of the present situation are far too serious to be dismissed on this optimistic note.

I think that the user should consider the other reasons there are for supporting an efficient smaller company quite apart from a more personal service and 'the national tendency in this country to support the individual in face of opposition from giant combines' to which you refer.

There are, at the time of writing, three giants. Two months ago we came within an ace of having only two. In a few years there may be only one.

Neither the users nor the smaller firms need fear even this situation were it not for further possible developments.

One should remember that there are many manufacturers who, having specialized in producing certain types of apparatus distribute their products, for efficiency and economy, only through laboratory furnishers. A few examples are Quickfit, E-Mil, Pyrex, Monax, Whatman and Electrothermal.

It is this type of specialist manufacturer who incidentally does quite a lot of the research and development which is credited in your article to the giants. In many cases in the past the initial outlet for distribution of the products of these specialists has been the smaller companies as the larger companies have naturally looked on some of the specialists as competitors.

In the event of finally one giant doing say 80 per cent of the laboratory trade these manufacturers will be in a very vulnerable position.

They can be more easily taken over by the giant or, at any rate, pressure can be put on them to give such advantageous terms to their one big customer as to make it economically impossible for the smaller firms however efficient, to carry on.

With the removal of the smaller firms the last spur to competitive service and prices will have disappeared.

As a matter of self interest, therefore, this is the prospect that the user should keep in mind when deciding whether to give a reasonable portion of his business to the efficient smaller company.

Yours faithfully,

R. MACINNES,
Managing Director,
Scientific Supplies Co. Ltd.

Scientific House,
Vine Hill,
London, E.C.1.

Acts of Uniformity

To the Editor,

Laboratory Practice.

DEAR SIR,—The editorial comment (*Lab. Pract.* 9(2) 91-92, Feb. 1960) is inaccurate and the reference quoted does not appear in the *World List of Scientific Periodicals*. Entry No. 855a and the accompanying cross-references are quite clear, but the editorial note in *Laboratory Practice* for February prints 'Tech.' for 'Rech.' as well as confusing two titles.

The suggestion that initial letters only should be used would lead to confusion unless a key was published each time, but the cost would be prohibitive. Library staff

should not find it necessary to refer to the *World List* every time, and the lower-case initial letter for adjectival terms helps to identify the country of origin—by language. Only where abbreviations develop to an identical form is the place of publication added to differentiate. These points (and others) are explained in the note on the abbreviations in the *World List*.

The complaints regarding format and presentation are justified, but these have been treated in *British Standard* 2509: 1959. But how are editors and printers to be compelled to comply?

Yours faithfully,

C. J. GOLLEDGE F.R.E.S.
Technical Librarian

Iranian Oil Services Ltd.,
London, E.C.2.

EDITOR'S NOTE.—*The abbreviation for the journal quoted in our Editorial was copied exactly from a list which appeared recently in a well known scientific journal.*

We would welcome further comments from our readers on this important subject.

BOOK REVIEWS

Annual Reports on the Progress of Chemistry for 1958. Volume LV. Published by the Chemical Society, Burlington House, W.1. £2. 2s. 0d.

There are two ways in which to review a book of this type—to consider the material or the presentation.

It is quite impossible to discuss the former in reviewing a book of this nature, so we shall confine ourselves to the latter aspect.

The Report is divided into six main sections: General and Physical, Inorganic, Organic, Biological and Analytical Chemistry and Crystallography.

The first section is, as stated in the introduction, rather specialized. It covers a few fields thoroughly, e.g. electrode processes, particularly with regard to adsorption problems, rather than giving a more detailed general report. The reporter states the intention over the next few years of covering all important and interesting subjects in this manner. The reviewer agrees that this treatment is preferable in that, besides the greater detail afforded, all the material relevant to any one subject will be grouped in one volume. There is one disadvantage, in that presumably, all new material published, on subjects considered in this volume, will have about three years delay before appearing in the reports.

The inorganic section is dealt with systematically. It considers first the main groups of the long form periodic table mentioning briefly work done on the elements of I and IIa, beryllium oxyacetate and similar compounds receiving special attention in IIa. The report on group IIIb reflects the present great interest in the chemistry of boron.

Varied reports on IV, V, VI and VIIb follow and the section ends with a discussion on the transition elements. Stress is laid on complexes and also on reports from the International Symposium of Co-ordination Compounds in Rome, 1957.

The organic chemistry section is the longest in the book and reports steady development in many branches. Quantum organic chemistry is reported on but only representative papers are quoted owing to the large volume of published work. The electron theory is discussed with application to heterocyclic and aromatic hydrocarbons. Free election models, hyperconjugation, bond lengths and hybridization are also considered.

The section on theoretical organic chemistry is broadly divided into heterolytic and homolytic processes, the former including nucleophilic substitution and aromatic re-arrangement and the latter considering free radicle intermediates.

General methods discussed include those for reduction, oxidation and alkylation and some using organometallic compounds. Sections on aliphatic, alicyclic, aromatic and heterocyclic compounds, steroids, alkaloids, carbohydrates and nucleic acids are also included.

The biological chemistry section includes a comprehensive report on the influence of metals on catalytic activity and another entitled 'Rare Sugars'. This deals with carbohydrates and illustrates the versatility with which living tissue transforms one sugar to another. Advances in phosphoglyceride chemistry are discussed and also the hydroxylation of foreign aromatic compounds in the animal body.

Analytical chemistry—here original papers are concentrated upon rather than abstracts. The reviewer agrees that this method of reporting favours practical techniques.

Gravimetric methods developed mainly concern inorganic work and the volumetric section reports a new primary alkalimetric standard and several new indicators. New uses for E.D.T.A. are also described.

A new test is reported in volumetric organic analysis for the determination of chlorine content of some organic chlorosilanes.

The electro-chemical section of 'Physical Methods' quotes the papers given at the Symposium on Modern Electrochemical Methods in Paris in 1957 and many others. Polarographic methods have apparently advanced mainly through the production of new and more sensitive instruments.

Chromatography is discussed including applications to organic analysis and a report on centrifugally accelerated paper chromatography. Adsorption spectroscopy, both organic and inorganic, emission spectroscopy, microanalysis and radio-chemical methods are reported. The section ends with a short account of new apparatus.

An interesting development in crystallography reported here is the foundation of the Groth Institute in the University of Pennsylvania, to collect all the existing information on physical and chemical crystallography.

General aspects of x-ray analysis, location of hydrogen atoms and the hydrogen bond, crystal structure analysis and the electronic spectra of crystals are discussed. The section ends with a discussion of both inorganic and organic structures.

The book covers an extremely wide field and in these days when time is short and scientific literature is enormous, this volume is exactly what is needed. It presents in a compact form most of the relevant information on new developments enabling one to keep up to date, and is liberally and clearly referenced so that one may easily follow up a subject of particular interest.

It is fully indexed under both subjects and authors' names.—P. J. STUBBS.

Electron Physics, by O. Klemperer, Ph.D. London: Butterworths Scientific Publications. 1959. 32s. 6d. pp. 248 + xi.

This book, based on lecture courses given to undergraduate students at Imperial College, is concerned with the physics of the *free* electron, essentially electron dynamics and optics. It is divided into two broad parts. The first deals with equations of motion in electric and in magnetic fields and also with electron trajectories. The necessary mathematics is reduced to a minimum and is clear and compact. Practical electron lenses and their applications to electron microscopes are discussed in some detail. Space-charge problems occupy a formidable chapter and this is followed by a very useful section on electron detectors, i.e. ionization chambers and counters.

The second part deals with fundamental properties of the electron. There are up-to-date sections on determination of e, e/m, relativistic electron mass, wave character of the electron, electron interference, electron diffraction, Schroedinger equation, electron magnetic moment, Zeeman effect.

This is an excellent book, well illustrated and well written. The content is surely admirably adapted to most university honours courses in this country. Each chapter has an appreciable number of problem questions set at the end and these are mainly questions set in the London Physics degree examinations during the past years. The discerning student will in fact detect that this book is a very good working text for the London degree.

We welcome this book as a very useful up-to-date text for the undergraduate in Physics. The price is reasonable and the book deserves a wide audience.—S. TOLANSKY.

Analysts Pocket Book, by J. R. Majer, B.Sc., Ph.D. (Lond.). London: Butterworths Scientific Publications. 1959. 17s. 6d. 100 pages.

Johnson's Laboratory Companion became out of print some 40 years ago and although various other handbooks and yearbooks have appeared none of them has really filled the gap. They have generally been too large being ready works of reference for a laboratory rather than a companion or pocket book. Certain well-known diaries supply part of the analyst's need, but not very effectively. Dr. Majer has made an effort at long last to supply the deficiency and one cannot but welcome the first appearance of the '*Analysts Pocket Book*'. This little volume will be found useful with certain reservations and doubtless every user will have his own idea about what should and should not have been included, but if everyone were to be satisfied we should again have a large volume.

Some of the information is repetitive as in the case of factors for sodium, while other useful matter has been either omitted or excessively compressed as in the case of primary standards, the preparation of standard solutions to which some three pages only are given, and buffer solutions which are covered in a page and a half. In its present form the handbook will appeal mostly to analysts engaged on inorganic work and to college students, but one looks forward to further editions, when the needs of a wider range of analysts has been considered.—T. McLACHLAN.

Instrumentation in Scientific Research, by K. S. Lion. London: McGraw Hill. 1959. 74s. pp. 324 + xv.

This book deals with input transducers in electrical instrumentation and is presented to those already familiar with a moderate knowledge of physics and mathematics. The subject is of course enormous and the content is divided into five main types of transducers namely (1) mechanical, (2) temperature, (3) magnetic, (4) electrical and (5) radiation.

Input transducers are systems which convert some form of energy into an electric signal. It is impossible in a review to list even a fraction of such applications but an *ad hoc* selection will indicate the kind of range covered in this comprehensive study: (1) length thickness and displacement gauges, (2) piezo electric transducers, (3) liquid level pressure gauges, (4) liquid flow measurement, (5) charge transportation, (6) humidity gauges, (7) resistance thermometers and thermocouples, (8) measurement of magnetic field, (9) Hall effect transducers, (10) permeability, (11) Faraday effect, (12) electric probes and measurement of electric fields, (13) photo-emissive transducers, photomultipliers and photoconductive cells, and (14) ionizing radiation detectors and counters.

There are a great number of excellent illustrations and the bewilderingly extensive list of subjects is described in precise detail with a vast amount of real experimental 'know-how'. Although where necessary, formulae are quoted, they are usually not derived, so that in fact little more than school mathematics is needed.

It is claimed that the book covers virtually all recent advances and this is certainly a reasonably justified claim. The style is easy, the production admirable. This is a most useful compendium, a handy reference for every serious undergraduate student of physics and electronics, an ideal source when preparing an essay.—S. TOLANSKY.

CONSTRUCTION OF METALLIC MULTI-POINT REPLICATORS

by E. D. Weinberg and Helen R. Arthur

Department of Bacteriology, Indiana University, Bloomington, Indiana, USA

WITHIN the past three years, several investigators have published reports of work in which metallic multi-point devices were used in place of velveteen or mohair pads for replication of microbial colonies.[1,2,3] In some cases, commercially available flower frogs have been employed; in others, replicating devices have been constructed in the laboratory. Flower frogs are usually too heavy and awkward for efficient handling, and very little information is available concerning either methods of construction or the utility of various possible materials that could be employed in the devices built by individual microbiologists. Several years ago, at the suggestion of Mr. Richard Eck, we began to use metallic multi-point replicators. After constructing and testing devices composed of many different materials, we now limit our production to the following model.

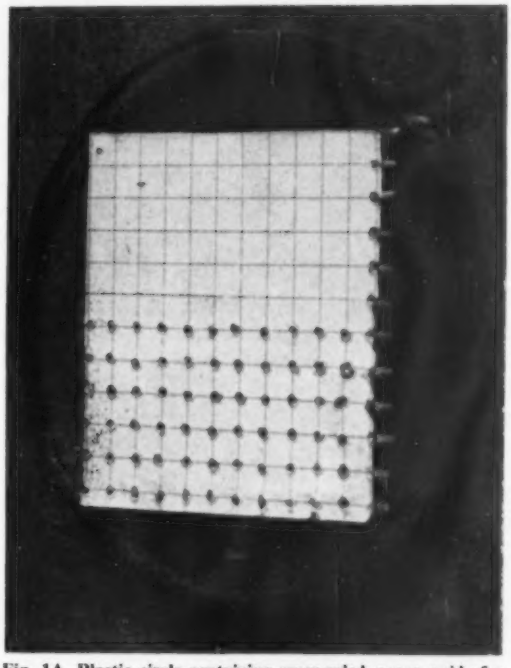

Fig. 1A. Plastic circle containing cross-ruled paper guide for drilling 144 small holes.

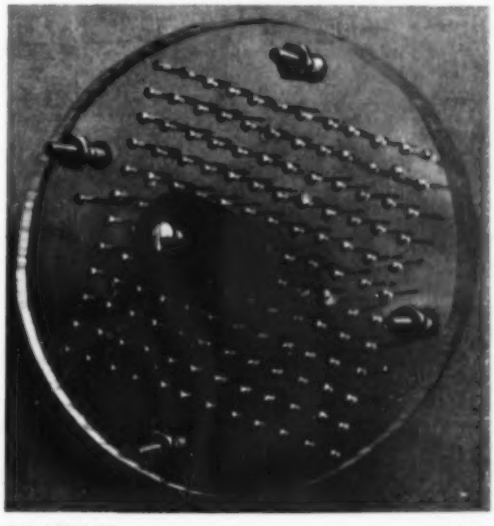

Fig. 1B. Top view of plastic replicator.

Materials

The articles required for each replicator consist of two circles of either one-quarter inch thick Plexiglas* plastic or one-eighth inch standard builder's masonite, 145 steel bank pins (Majestic No. 16), four brass screws (No. 4, one inch length) with machine nuts to fit, one brass screw (No. 4, one and one-half inches length), and one rubber stopper (No. 00, one hole). Additional materials needed are sheets of one-quarter inch cross-ruled paper, rubber cement or double-faced adhesive tape, a No. 60 metal machine drill bit, and a No. 33 metal machine drill bit. Access to a standard type machine shop jigsaw and to a standard type machine shop drill press is also required.

Fabrication Procedure

Two circles of plastic or masonite are cut to a diameter of $3\frac{7}{16}$ in. with a jigsaw. By means of rubber cement or double-faced adhesive tape, a sheet of one-quarter inch cross-ruled paper measuring $2\frac{3}{8}$ in. square is secured to circle No. 1. The square sheet of paper, which is centred evenly on the circle, contains 144 points that represent the intersections of 12 lines. At each point of intersection, a hole is drilled through the plastic or masonite by means of a No. 60 drill bit powered by a drill press. Caution must be used in the drilling process especially if plastic rather than masonite is used, as the No. 60 bit is quite flexible and has a tendency to veer out of alignment if the bit is admitted too rapidly into the plastic surface. To permit orientation of the replicator, an additional hole is drilled in the centre of one of the four segments of the circle outside of the square of perforations.

*Trade mark of Rohm and Haas, Philadelphia, Pennsylvania

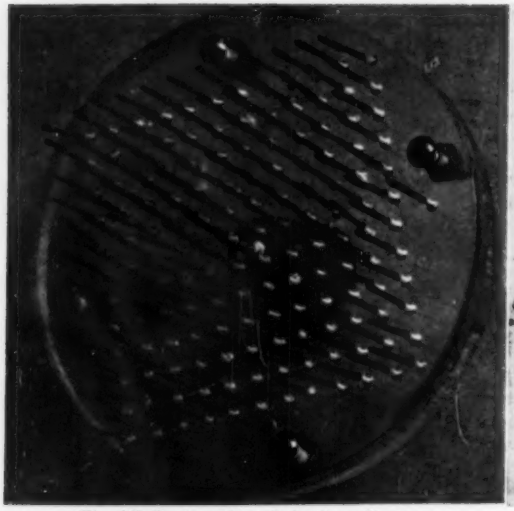

Fig. 1C. Bottom view of plastic replicator.

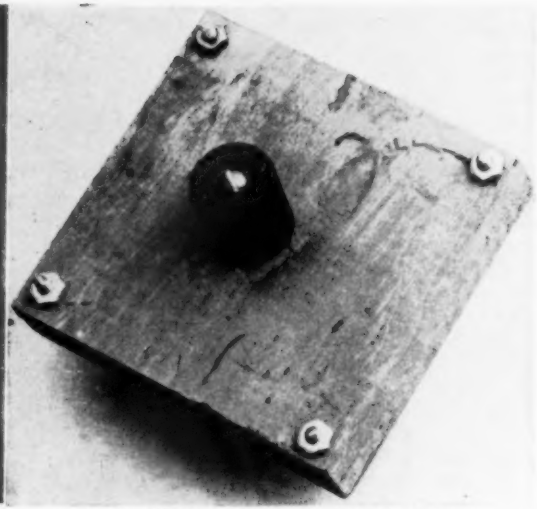

Fig. 1D. Top view of masonite replicator.

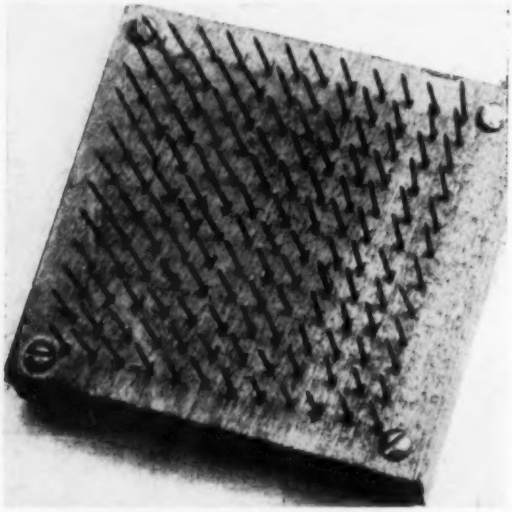

Fig. 1E. Bottom view of masonite replicator.

By means of the No. 33 bit, a hole is then drilled in each of the four outer segments beyond the perforated area, approximately one-quarter inch from the circumference of the circle. With the same bit, four holes are drilled in circle No. 2 at such points that the holes will coincide with the four holes that had been drilled in circle No. 1. The purpose of these holes is to accommodate the one inch brass screws used to secure the two circles together. In addition, a hole is drilled in the centre of circle No. 2 by means of the No. 33 bit. A brass screw, one and one-half inches long, is threaded through a No. 00 rubber stopper and fitted into this hole, thus providing a handle for the replicator.

The cross-ruled paper and tape are removed from the No. 1 plastic circle and No. 16 Majestic steel bank pins are inserted in the 145 small holes. The two circles are then joined tightly by means of the four one-inch brass screws and the appropriate machine screw nuts. The four screws are placed in the direction opposite to that of the pins so that the former will not touch the edges of the petri plates during replication. A plastic circle with a cross-ruled paper guide, an assembled plastic replicator, and an assembled masonite replicator are shown in Fig. 1 A, B, C, D and E.

Discussion

The approximate time required by a non-experienced operator for construction of a single replicator is one hour. The cost of the plastic is $2.79 per square foot; as nine circles can be obtained from a square foot, the total cost of the plastic per replicator is 66 cents. The pins, screws, nuts, and rubber stopper for a single replicator can be obtained for approximately 10 cents.

The advantage of plastic over such materials as masonite is that no warping occurs even after prolonged autoclaving. On the other hand, the cost of masonite is approximately one-thirtieth that of plastic, and masonite is somewhat easier to drill. If the replicators are to be sterilized only by means of ignited alcohol and not by autoclaving, then devices made of either plastic or masonite are equally suitable.

In agreement with other investigators who have used metallic multi-point replicators, we have found them to possess many advantages over velveteen pads. In addition to the two main applications of replica plating (classification of colonies differing from each other in nutritional requirements and isolation of new mutant strains) for which the metallic devices are quite useful[2], we routinely employ the replicators to differentiate

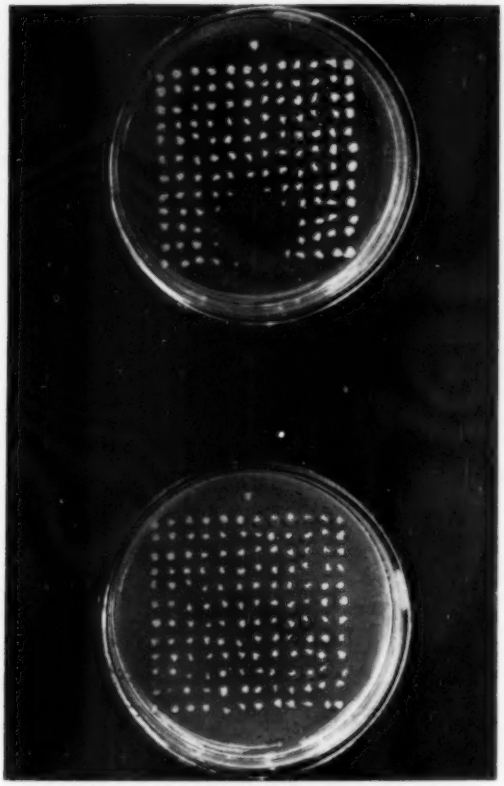

Fig. 2A (top). Ability of oxytetracycline added to nutrient agar plate at time of inoculation to prevent formation of visible colonies of *Staphylococcus aureus*. B. (below). Demonstration by replication from plate A (after removal of disc) to plain nutrient agar that oxytetracycline was bacteriostatic rather than bactericidal towards the inoculum of plate A.

etween the bactericidal and bacteriostatic effects of ntibiotics. An illustration of the latter application is iven in Fig. 2. It may be observed that the cells on late A that were prevented from forming visible olonies by the antibiotic were nevertheless still viable ecause, upon replication to plate B, a complete set of olonies appeared after the appropriate period of cubation.

CKNOWLEDGMENTS.—*It is a pleasure to acknowledge he financial support of the National Institute of Allergy nd Infectious Diseases, U.S. Public Health Service Grant E-2252) and the technical assistance of Misses udith Donaldson and Sharron Nance.*

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Recent British Standards

Density Hydrometers for Use in Milk

The issue of this revised publication (B.S.734, Part 2: 1960—Methods, price 7s. 6d.) marks the first step towards the complete revision of B.S.734:1955—a task which will see fulfilment with the impending issue of Part 1, 'Apparatus'.

Part 2—'*Methods*' specifies procedures for determining the density of milk with the fat in either wholly the liquid state or wholly the solid state. It also provides tables relating the known fat content and measured density of milk to percentage of S.N.F. in the milk under test.

Three sizes of hydrometer are specified, the intermediate size (No. 2) having been modified to make it more robust.

The standard features an important innovation: it prescribes the use of hydrometers calibrated to be read at the top of the milk meniscus.

Two equations relating known fat content and observed density of milk at 20°C., with S.N.F. content are given: (*a*) with milk fat in liquid state, and (*b*) with milk fat in solid state. Tables corresponding to these equations are provided covering fat content ranges of from 2·00 per cent to 6·00 per cent in both cases.

Suitable metal hydrometer jars are recommended and these have been modified so as to provide a slightly increased clearance between the bulb of the hydrometer and the wall of the jar.

Methods for the Analysis of Water-soluble Coal-tar Dyes permitted for use in Foods

At the request of the Ministry of Agriculture, Fisheries and Food, the British Standards Institution has undertaken the preparation of specifications for the colouring matters permitted for use in foods by the colouring matters permitted for use in foods by the Colouring Matter in Food Regulations, 1957. These regulations name 29 dyes manufactured from coal tar, together with caramel, cochineal colour, various colouring matters of vegetable origin, and certain pigments and lakes.

As an essential step in this work, appropriate methods of analysis which are generally applicable to the water-soluble coal-tar dyes in the permitted list have been collected in B.S.3210 (price 7s. 6d.) to which reference will be made in subsequent British Standards covering the individual colouring matters. Methods are given for the determination of matter volatile at 135°C., matter insoluble in water, di-isopropyl ether extract, subsidiary dyes, chloride, sulphate, dye content, copper, arsenic and lead. A limit test for heavy metals (as sulphides) is also included.

Prepared by a technical committee representative of dye manufacturers, food manufacturers, research associations, Government departments, and scientific and professional organizations, this British Standard provides a set of methods which will be indispensable to all concerned with the examination of food colouring matters.

Copies of these Standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

Appointment of Government Chemist

Dr. D. T. Lewis has been appointed Government Chemist. He succeeds Mr. E. H. Nurse, C.B.E., who has been acting Government Chemist since the death of Dr. G. M. Bennett, C.B., F.R.S., in 1959.

Dr. Lewis, who is 50, has for the last seven years been Senior Superintendent in charge of the chemistry division at the Atomic Weapons Research Establishment, Aldermaston. In 1958, he was present at the series of trials of British atomic weapons at Christmas Island. He has published a number of important papers in scientific journals dealing with researches in inorganic, physical and analytical chemistry. He is also the author of 'Ultimate Particles of Matter', a book on nuclear science written to introduce laymen to the subject.

THE ROLE OF PLASTICS IN THE CONSTRUCTION OF LABORATORY APPARATUS

by D. D. P. St. John, B.Sc., A.R.I.C.
Technical Manager, Loughborough Glass Co. Ltd.

PART II

Hydrometer Jar
Fabricated from polythene a virtually unbreakable hydrometer jar is now available, so constructed that any overflow when the hydrometer is inserted is caught in an annular well thus preventing any spillage on to the bench or operator (Fig. 12).

Magnets
For use with magnetic stirrers it is now possible to obtain metal cores enscapulated in polythene or P.T.F.E. They are obviously superior to the glass covered stirrer as there is no danger of breakage leading to contamination of the solution. One company is offering a particularly useful form of this stirrer with a moulded ring round its circumference at the centre on which it pivots.

Measuring Cylinders
Moulded polythene measuring cylinders are rapidly becoming a familiar sight in the laboratory as they offer complete freedom from breakage. Although no measuring cylinder, whether glass or plastics should be used for accurate measurements it is generally considered preferable to use a polythene measure which has been graduated after moulding rather than one in which the graduations are moulded in. This is due to the fact that slight variations in the moulding conditions can materially affect the wall thickness and even the shape of the measure, thus affecting its accuracy. Polythene measuring cylinders over the range of 10 ml. to 10,000 ml. are available which are claimed to be individually calibrated within the tolerances of BSS 604.

Fig. 12.

Fig. 13.

One of the disadvantages of polythene for this application is the lack of transparency and already measures moulded from polypropylene are beginning to appear, this material being less opaque than polythene. However, this improvement is only marginal and where good clarity is essential acrylic measures are available, these being of particular interest to the food and brewing industries. In these industries glass cylinders cannot be tolerated because of the danger of breakage and undetected glass splinters being present in the food product Acrylic cylinders are much more robust and even if they are broken do not give rise to splinters and the large pieces can more readily be detected.

Mercury Collectors
Every laboratory worker has at some time or other been faced with the problem of recapturing spilled mercury. Although not a perfect answer, as it is really only suitable for use on a flat surface, a useful device known as the 'Polysyn' mercury collector has recently been introduced (Fig. 13). It consists of a polythene container with a screwed top, a polythene tray and a threaded polythene lid with an inserted plastic foam pad. To collect mercury the lid with the foam pad is pressed firmly against the surface on which the mercury has

been spilled so that the globules are covered. The pressure applied will open the cells in the foam pad so that the globules can enter the cells; when the pressure is released the cells close up retaining the mercury globules. The lid can then be screwed back and the pressure created by closing the container is sufficiently strong to reopen the cells in the foam pad and so release the mercury which collects at the bottom of the container. The mercury can then be readily poured out of the container.

Non-return Valve

Non-return valves are widely used in the laboratory, for example, between vacuum flasks and water jet pumps to prevent damage due to 'suck back'. A moulded polythene non-return valve (Fig. 14) is available and it is very suited to this application as it is compact, unbreakable and can readily be taken apart for cleaning. The working part of the valve is a thin P.V.C. diaphragm and although organic solvent vapours will eventually cause shrinkage of the diaphragm, this can readily be replaced. This valve is suitable for use with tubing around $\frac{1}{4}$ in. bore.

Petri Dishes

A standard item of equipment on all biological laboratories is the glass petri dish but their breakage rate is quite high, particularly in the hands of the unskilled labour often used to carry out the necessary sterilization. Polythene and cellulose acetate dishes have been on the market for some time but have not proved successful because they cannot be steam sterilized and the former also lacks transparency. The position of the glass dish is likely to be seriously challenged however, by the use of presterilized, prepackaged polystyrene dishes which have been available in the States for some time but are only just beginning to appear in this country. They are expected to be cheap enough to be disposable and the advantages of being able to incinerate completely the dish and culture after use are obvious. Sterilization of the units is achieved either by gas techniques or irradiation, and until the package is broken open the dishes should remain sterile indefinitely.

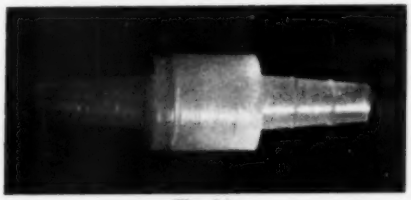

Fig. 14.

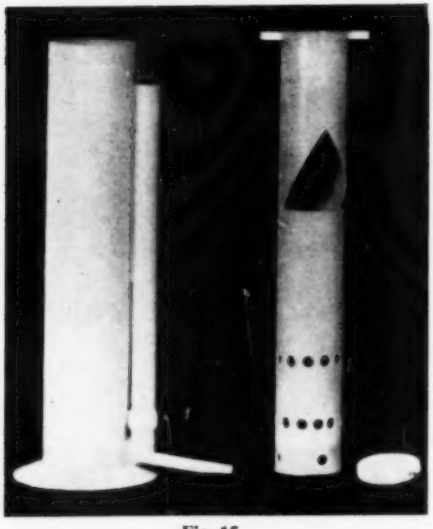

Fig. 15.

Fig. 16.

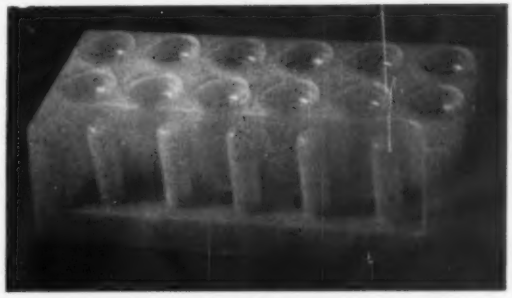

Fig. 17.

Pipette Washers

Although because of the difficulty of calibrating, plastics burettes and pipettes are not a practicable proposition, pipette washers and baskets constructed from polythene are a considerable improvement over previously used materials because they markedly reduce the possibility of accidental damage to glass pipettes. One form of these is supplied with a foamed plastics pad in the bottom of the basket to reduce still further the possibility of accidental damage. It also has a cut-out in the basket to facilitate the removal of short pipettes (Fig.15).

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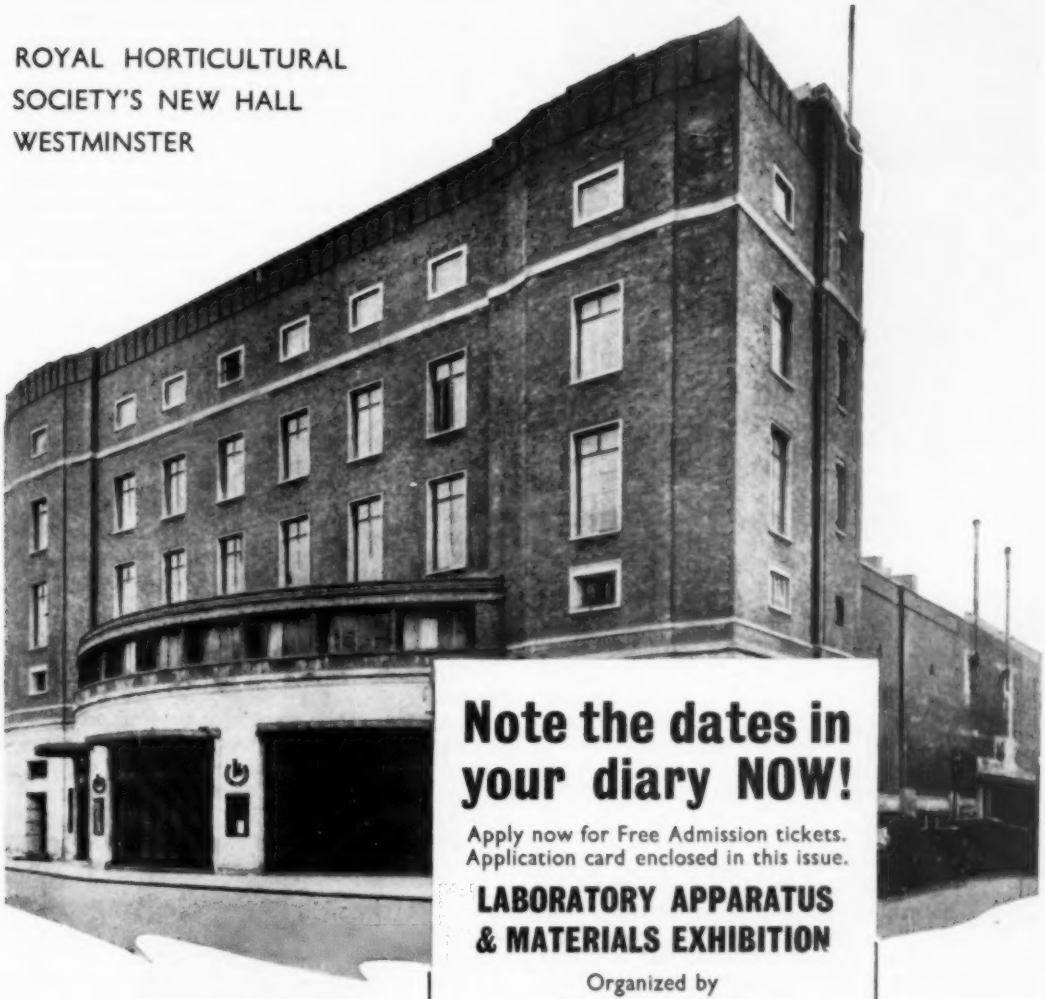

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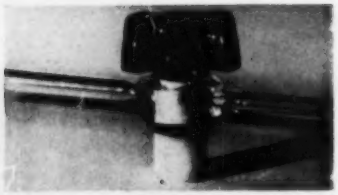

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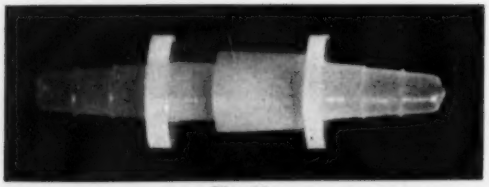

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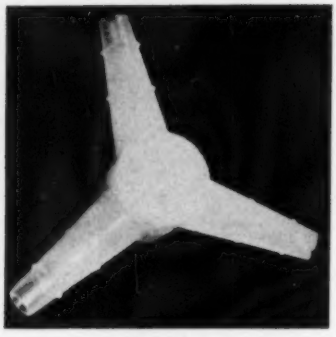


Fig. 20.

P.T.F.E. Sleeves

It has been said that one of the greatest advances in the development of glass laboratory apparatus was the introduction of interchangeable ground glass joints. It could fairly be claimed that one of the greatest advances in the development of the use of ground glass joints was the introduction of a P.T.F.E. sleeve in the form of a truncated cone approximately ·002 in. thick accurately tapered so that the sleeves fit snugly to the appropriate glass cone. The use of these sleeves prevents the joint sticking without the necessity of using any grease and the resultant possibility of contamination of the product (Fig. 16). These sleeves are not damaged by any known solvent and can be used over the temperature range —75°C. to 250°C. They are sufficiently vacuum tight for most ordinary vacuum distillation processes. They are durable, can readily be cleaned and used over and over again. Sleeves are available over the whole range of joint sizes from B7 to B55.

Stirrer Rods

A simple but extremely useful arrangement is a polythene tube with a sealed-in mild steel rod reinforcement. It is available in sizes ranging from 6 in. to 24 in. long and offers the advantages of a rigid metal rod but with complete freedom from chemical attack. The polythene sheath also reduces the possibility of accidental damage to the container.

Sintered Plastics

Polythene and P.V.C. sinters are available in a range of pore sizes. One application is the aspirator stopper already described, but they also find useful application as filters and as column supports. A more novel application is the use of sintered plastics tubes sealed at one end as air leaks for flasks, etc., and because of the reduction in weight and the fact that they are constructed in plastics, they are far superior to sintered glass funnels commonly used for this purpose. The tubes are also useful as gas bubbler, filter candles, etc.

Spatulas

A number of designs of spatulas constructed in polythene or P.V.C. are available, but of particular interest is one designed for caterers which, due to the blade design, is very useful for scraping the sides of containers. Being constructed in polythene there is no danger of scratching the surface of the container.

Test Tubes Racks

Possibly the most untidy piece of equipment in the laboratory is the ordinary wooden test tube rack. Because of their freedom from chemical attack plastics offers the opportunity for maintaining good appearance as they are virtually unaffected by spillage. Test tube racks of various designs have appeared constructed in polythene, P.V.C. or Perspex and generally they are somewhat expensive. One design worthy of note is illustrated (Fig. 17). This incorporates drainage pegs as well as serving as a test tube rack, and is moulded in standard polythene. The temperature limitation of polythene still holds however, and no very hot object should be placed on it.

Stopcocks

Many attempts have been made to produce a leak-proof, easy-action plastics stopcock but generally only

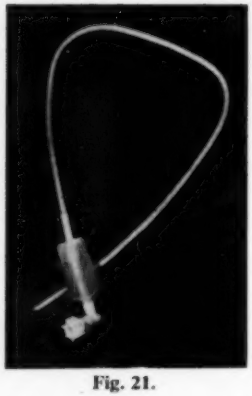
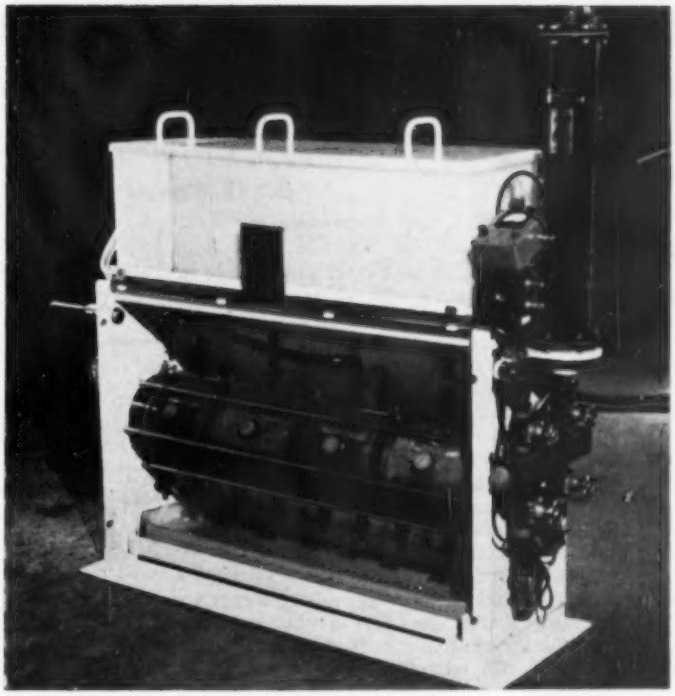


Fig. 21.

Fig. 22.



with limited success. However, one company has recently produced a novel design of plastic/glass stopcock in which a specially shaped P.T.F.E. plug rotates in a reinforced all-glass body (Fig. 18). The use of P.T.F.E. means that no lubrication is required, no seizure in the presence of caustics will occur, while the use of an all-glass body means that the stopcock can readily be incorporated in glass apparatus by standard techniques. This stopcock is also suitable for ordinary vacuum distillation processes, and although too expensive to serve as a replacement for a standard glass stopcock, should prove very useful when dealing with those 'awkward' jobs.

Tubing Connectors

Possibly one of the most commonly —and most carelessly—performed operations in the laboratory is the connecting up of rubber or plastic tubing to glass apparatus. The difficulty of removing such tubing when it is desired to move or dismantle the apparatus is well-known and most chemists can point to at least one scar resulting from such operations. The use of a simple tubing connector moulded in polythene completely overcomes this danger to the user and to the apparatus. One company is offering a moulded polythene connector made in two parts, a cone and socket with tapered ends that will take tubing up to $\frac{1}{4}$ in. bore (Fig. 19). To join, the cone is simply pressed into the socket and gently rotated. This connector is suitable for general vacuum work and has withstood pressures of up to 50 p.s.i.

The same company is also offering moulded polythene 3-way connectors (Fig. 20) the limbs being at 120° to each other so that the same connector can satisfactorily function both as a 'Y' piece or as a 'T' piece. This again is a valuable contribution towards increased safety in the laboratory and doubtless other similarly interesting mouldings will follow.

Chemical Plant

Plastics find wide application in the construction of tanks, valves, pipelines, pumps, etc., but this is somewhat outside the scope of the present paper. However, one plant application worthy of note also to the laboratory technician is a simple device for transferring the contents of carboys to other vessels. Essentially it consists of a length of polythene tubing passing into a flexible chamber to which is fitted a polythene control valve (Fig.) 21. These syphons can readily be inserted into the neck of a carboy no stopper being required. To prime, the valve is closed and the flexible chamber compressed thus creating a vacuum. When the pressure is released the liquid syphons over and the flow can then be regulated by means of the valve. Once primed, repeat flow of the liquid is controlled solely by the valve.

Another extensive use of plastics in chemical plant is in the form of protective coatings applied to metal. Polythene, P.V.C., nylon and, to a more limited extent, P.T.F.E. are used for this purpose. A laboratory application of interest is a water deionizer which employs the replaceable cartridge principle. A metal cartridge is used and in order to provide adequate protection against abrasion both from handling and from the effect of movement of the ion-exchange resin, a nylon coating is used. This coating also provides protection against the corrosive effect of conductivity water without in any way impairing the quality of the water. For supporting the complete deionizer a P.V.C. coated metal cradle is used, the P.V.C. coating providing adequate protection against normal laboratory spillages, while providing a non-scratch support for the deionizer unit.

Also from the same company is a larger deionizer (Fig. 22) the 'Stonwata' A300/1, which particularly well illustrates the use of plastics in the design of laboratory equipment, utilizing as it does some seven different plastics. The ion-exchange resins used are based on polystyrene, and are contained in Perspex cells closed

(*Concluded on page* 247)

POLARIMETRY AND REFRACTOMETRY IN THE LABORATORY

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Optical Consultant

PART II—REFRACTOMETRY

Theory

The refractive index, n, of medium a with respect to medium b is defined as sin i/ sin r, where i is the angle of incidence in medium a and r is the angle of refraction in medium b. The values of n for solids and liquids ordinarily quoted in the literature refer to air at the temperature and pressure of the measurement. The correction to air at S.T.P. (0°C., 760 mm., dry) is usually of the order of 1×10^{-5} and is thus negligible for most purposes. The values of n for gases are usually referred to a vacuum as the reference medium.

The refractive index is temperature dependent. For many liquids the temperature coefficient (i.e. increase of n for 1°C. rise in temperature) is about -4×10^{-4}; however, near the boiling point many liquids have a value around 7×10^{-4}. Solids differ among themselves far more than do liquids; the values may be either positive or negative and are numerically much smaller than those for liquids. The refractive index of gases is even more temperature dependent. Hence in any work on gases and in the most accurate work on solids and liquids, it is necessary to specify the temperature of the determination

The refractive index depends strongly on wave-length. In regions remote from an absorption band, n decreases gradually with increasing wave-length; this behaviour, known as normal dispersion, is roughly expressed by the Cauchy formula:—

$$n = A + B\lambda^2 + C\lambda^4$$

where A, B and C are empirical constants. Within or near a region of absorption, n generally changes sharply.

Instruments

Measurements of the refractive index of gases can only be made interferometrically; such methods have also been applied to liquids. Interferometric methods will not be described here, but a survey has been given by Bauer (1945). The remaining refractometers fall into two classes: those which depend on the measurement of critical angle and those which do not.

Critical Angle Refractometers

In these, light passes through the substance under investigation or is reflected at it into a glass prism of higher refractive index; the light is observed on emerging from this prism. The path of the light for passage through the substance is shown in Fig. 6. It is obvious that no angle of refraction greater than that corresponding to an angle of incidence of 90° is obtained. This

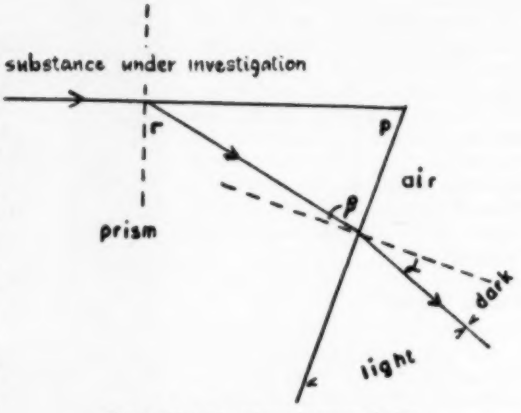

Fig. 6. The critical ray in transmission.

angle of refraction is known as the critical angle and the corresponding ray as the critical ray. As shown, the critical ray marks the demarcation between light and dark regions. In refractometers the whole surface of the prism is illuminated rather than one point. A telescope focused on infinity is used to view the emerging light so that all rays with the same angle of refraction are focused into one line in the focal plane. Hence, for monochromatic illumination, a sharp line of demarcation between a bright and dark field is observed. Let the angles be as shown in Fig. 6 and n and n_p the refractive indices of the substance under investigation and the prism respectively. If n'_p is the refractive index of the prism with respect to the substance under investigation,

then $n'_p = \sin 90/ \sin r = 1/ \sin r$

also $n = n_p / n'_p$

hence $n = n_p \sin r = n_p \sin (p - \beta) = n_p (\sin p \cos \beta - \cos p \sin \beta)$

since $\sin \alpha / \sin \beta = n_p \therefore n = n_p (\sin p \sqrt{1 - \sin^2\alpha / n^2_p} - \cos p \sin \alpha / n_p)$

i.e. $n = \sin p \sqrt{n^2_p - \sin^2\alpha} - \cos p \sin \alpha.$

Hence, by observing α, n may be determined if n_p and p are known. The formula may be shown to apply also

when light is reflected at the interface of the prism and the substance under investigation. The critical ray then corresponds to no transmission into the substance; it thus forms the boundary between light and less light parts of the field and is therefore less easily observable than the light-dark boundary of Fig. 6.

There are two main types of instrument based on this theory: the Pulfrich and the Abbé. The values of p are 90° and 60° respectively; hence, for the Pulfrich, the above formula simplifies to $n = \sqrt{n^2_p - \sin^2\alpha}$. The optical systems of the two instruments are shown, in principle in Fig. 7 (a) and (b) respectively. The similarities and differences between them are as follows:

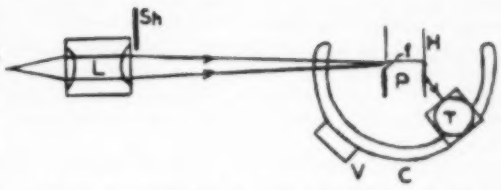

Fig. 7 (*a*). The optical system of the Pulfrich refractometer.

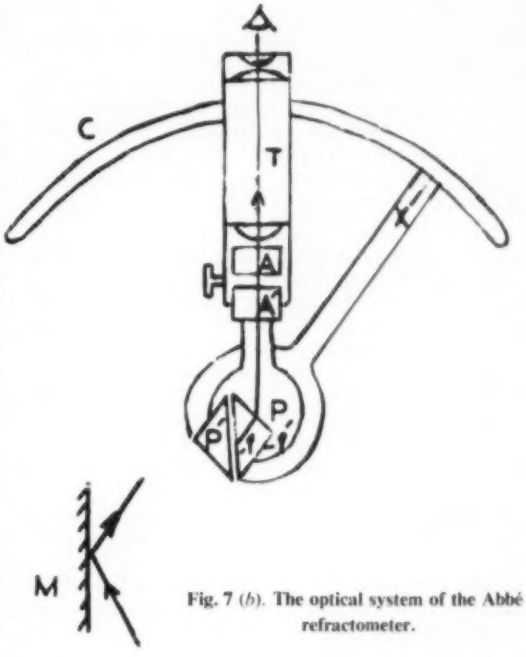

Fig. 7 (*b*). The optical system of the Abbé refractometer.

Illumination

For the Pulfrich, either light of a single wave-length or a mixture of discrete wave-lengths is used. Suitable sources are the sodium and mercury vapour lamps and the helium discharge tube; single wave-lengths (for mercury and sodium values see Part I) may be isolated by means of filters. Although not so convenient as the other sources, the helium tube gives a spectrum which includes the long wave-length lines (6560, 6678 and 7065 A) which are absent from the sodium and mercury spectra. For maximum intensity in the field of view, an image of the source S is focused on the face of the prism P. The final adjustment of the condenser L is made by moving it until the critical boundary viewed through the telescope T is as sharp as possible. When monochromatic light is used and shutter Sh is wide open, one half of the field is wholly bright. As Sh is closed, the bright part narrows, because the range of values of angle of incidence (and hence that of refraction) is obviously reduced. When a mixture of wave-lengths is used and Sh sufficiently narrowed, a separate sharp critical boundary is seen for each wave-length. Thus the Pulfrich serves as its own monochromator; it is possible to resolve the sodium D lines with the instrument.

White light is used in the ordinary Abbé refractometer. It is reflected by mirror M into the prism P^1 which is hinged so that its ground glass hypotenuse is either swung out or clamped almost in contact with the refracting prism P. The substance under investigation is between P and P^1. Two Amici prisms A and A^1 are inserted in front of the telescope objective; by rotating one of these relative to the other, dispersion equal and opposite to that of P and the sample is produced and so the critical boundary appears sharp and colourless. The prisms are such that light of sodium D wave-length is not deviated; the index measured is therefore that for the sodium D line. Recently a precision Abbé refractometer using monochromatic light has been developed; a compensator (AA^1) is then not required.

Viewing

There is a reflecting prism (as shown in Fig. 7(a)) in front of the telescope objective of the Pulfrich; this allows the telescope T to be mounted with its axis horizontal. The telescope is rigidly attached to a rotatable circle C and rotations are measured by the vernier V. Slow motion of the circle over about 5° of arc is available. When the critical boundary is on the eyepiece crosswire, the scale reading gives the critical angle, provided the telescope axis is normal to the surface of P when the scale reading is zero. This can readily be checked as the telescope is of the auto collimating type and the correction, if any, found. The refractive index may be read off from tables supplied with the instrument.

In the Abbé, the telescope T is also rigidly attached to a rotatable sector C but the prism P is not fixed. It can be rotated about the same axis as the sector and its position is indicated on the sector scale by a mark X on an arm attached to its mounting. The sector scale is directly calibrated in refractive index for sodium D. The Abbé is therefore quicker to use. However, accidental changes in calibration are more likely to occur in a direct reading instrument and so it is advisable to make

checks from time to time by measurements on samples of known refractive index.

An Abbé type refractometer has been developed in which the position of the achromatic critical boundary is observed on a scale in the telescope eyepiece; the sector is then dispensed with. In this refractometer, known as the dipping refractometer, the prism P is rigidly attached to the objective end of the telescope and prism P^1 is dispensed with. Calibration by measurements on known substances is needed.

The Handling of Various Materials

Transparent liquids.—For the Pulfrich, the liquid is contained in a simple cylindrical tube H which is ground at the base to fit the prism. In the Abbé, the locking together of prisms P and P^1 suffices to hold a thin film (0·1 mm.) of liquid against P. The minimum amount of liquid required is about 0·2 cc. for the Pulfrich and 0·05 cc. for the Abbé. For the dipping refractometer, P is immersed directly in the liquid.

Solids (*Large pieces of transparent solids*).—The technique is the same for all instruments. It is necessary for the material to be homogeneous and have two mutually perpendicular faces one of which is plane and clear; the perpendicular faces should intersect in a sharp line. The clean plane face is brought into contact with the face f of P by placing a drop of liquid of higher refractive index than the solid on f and carefully pressing the solid into place so that a very thin bubble free film separates the two surfaces. Any excess liquid is removed as it would cause blurring of the critical boundary. If the liquid film is wedge shaped, errors may arise in the fourth decimal place of the refractive index. The slope of the wedge may be observed by viewing the interference fringes it gives rise to at the exit pupil of the telescope; the sample is pressed at various points until the fringes become fewer: for fourth place accuracy, 6—8 fringes are permissible, for fifth place only one.

In the Abbé instrument, P^1 is lowered as far as possible and then sends light into the sample.

Powders (*from transparent solids*).—Only the Pulfrich is suitable for this work. If powders are immersed in a liquid of identical refractive index and viewed in the usual way for liquids, a sharp critical boundary may be found. If the indices of liquid and powder are slightly different, the boundary is diffuse or non-existent. Two liquids are selected whose refractive indices are respectively above and below that of the solid. The powder is mixed with one liquid and the other poured in until the boundary line becomes sharp.

Opaque or coloured solids and liquids.—For these reflection must be used. The Abbé is most suitable for such measurements. It is slightly modified by illuminating surface f^1 through a diffusing screen. Light is then reflected from f, which is covered with the sample, and enters the telescope.

General

When the investigation of any substance is completed, the delicate prism surfaces should be cleaned with alcohol; they should only be touched with soft lens paper. Before the next measurement, the prism should be rinsed with the liquid under investigation, or, with the contact liquid if measurements are being made on a solid.

Temperature Control

In both the Abbé and the Pulfrich, temperature control is secured by mounting the prisms in jackets through which thermostatted water can be circulated; this gives temperature control of a sample to 0·2°C. An improved container for liquids, giving temperature control to 0·02°C. has been developed for use with the Pulfrich; it is thermostatted, excludes the atmosphere and allows rapid filling and draining. For the dipping refractometer, temperature control is secured by adjusting the temperature of the liquid under investigation itself.

If the working temperature differs by more than about 5°C. from that of the room, disturbing temperature gradients are set up and so it is better to place any refractometer in an insulated box which can be thermostatted to ±1°C. This also defines the temperature of the reference medium air. To ensure temperature equilibrium of the prism, thermostatting should commence about 20 minutes before readings are taken; readings should not be recorded until they have been constant for five minutes. If the temperature of measurement is very different from that of the room, it is important to take into account the change in refractive index of the prism (n_p) with temperature.

Dispersion Measurements

The dispersion has been defined as the difference between the refractive index values for the F and C hydrogen lines. However, the hydrogen discharge tube is a relatively inconvenient source, so, it is easier to measure the refractive index difference for blue and red helium lines. This may readily be done with the Pulfrich and precision Abbé instruments.

For the ordinary Abbé and dipping refractometers, it is obvious that the greater the dispersion of the sample, the greater will be the rotation of the compensator AA^1 necessary to produce an achromatized critical boundary. For these instruments, the dispersion is given by $A + kBS$, where A and B are constants depending on the refractive index of the specimen for the sodium D line; k corrects for certain errors in each individual instrument; S is a function of the compensator setting. A, B and S are found from tables supplied. If these instruments are used for dispersion measurements, their reliability should first be investigated by measurements on known substances.

Accuracy

Table 1 shows the maximum accuracy and range of the various critical angle refractometers:

TABLE I

Refractometer	*Maximum accuracy in n_D*	*Maximum accuracy in dispersion*	*Range of n*
Pulfrich	$\pm 1 \times 10^{-4}$	$\pm 2 \times 10^{-5}$	1·33 – 1·86
Abbé	$\pm 1 \times 10^{-4}$	$\pm 1 \times 10^{-4}$	1·3 – 1·84
Precision Abbé	$\pm 2 \times 10^{-5}$	$\pm 2 \times 10^{-5}$	1·33 – 1·7
Dipping	$\pm 7 \times 10^{-5}$		1·32 – 1·54

For the ranges quoted above, more than one prism is required for each of the various instruments.

Disadvantages of Critical Angle Refractometers

The main disadvantages are:

1. Unsymmetrical field of view: setting cross wires on a demarcation line symmetrically illuminated on both sides is more accurate than setting on a demarcation line between light and dark fields.
2. Measurements cannot be made on substances whose refractive index is greater than that of the refractometer prism.
3. The index measured is that of a surface layer which may or may not be the same as that of the main bulk of the specimen.

Non-critical Angle Refractometers

The Hilger-Chance.—This instrument was developed (see Hilger Catalogue CH 312/3) to overcome the disadvantages just described. It is shown in side elevation in Fig. 8. The glass block B is formed from two prisms as indicated; they are united by heat treatment and the join will withstand the action of all usual solvents. The angle of the V-block is 90° and the substance under investigation U is placed in the groove as indicated. The slit S is illuminated by monochromatic light which is made parallel by lens C. The change in direction produced in B obviously depends on the refractive index of the specimen. The change is measured by telescope T, which, as in the Pulfrich instrument, is fitted with a reflector, so that it may be mounted with its axis horizontal. The setting is made on the image of the fine line which runs along the middle of S; hence the instrument has the advantage of a symmetrical field of view.

It is obvious that two perpendicular faces must be produced on solid specimens; these faces need not, however, be of the highest optical quality as a film of liquid can be placed between the faces of the specimen and the V block. For use with liquids, the V-block is provided with side plates to form a trough; 2—3 cc. of liquid are required. The instrument does not measure the refractive index of the surface layers.

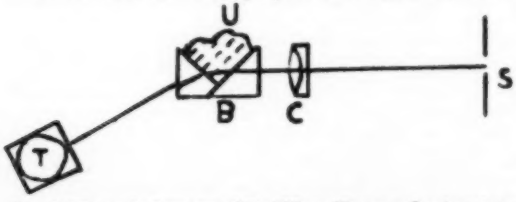

Fig. 8. The optical system of the Hilger Chance refractometer.

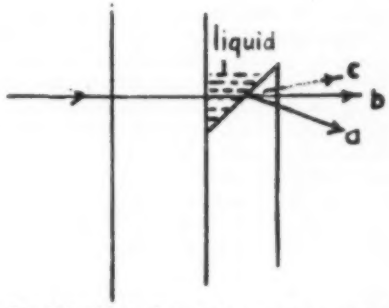

Fig. 9. Liquid holder in Jelley micro-refractometer. Rays a, b and c are respectively for a liquid of refractive index less than, equal to and greater than that of the glass.

As the instrument is not of the critical angle variety, measurements are not confined to substances of refractive index less than that of the block; this can therefore be made of durable glass of moderate index. The accuracy of the instrument is $\pm 1 \times 10^{-5}$.

For measurements of refractive index of small quantities—Techniques employing a microscope will not be described here, but a survey has been given by Jelley (1945).

For liquids, several workers have developed the image displacement method. In principle they resemble the Hilger-Chance instrument, except that the angle of the liquid prism is 45° and only a drop of liquid is used. In the Jelley microrefractometer (1939) liquid is held between a plane and a bevelled glass slide as indicated in Fig. 9. The accuracy is ± 0·002 and measurements have been made over a wide temperature range.

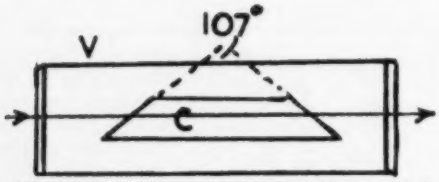

Fig. 10. Cell of the Amagat and Jeans differential refractometer. The light path shown is for liquid in C of equal refractive index to that in V.

Differential Refractometers.—The purpose of such instruments is to measure the difference of refractive index between two liquids. A collimator and telescope are rigidly mounted facing each other. Between them is the cell, which, in the Amagat and Jeans instrument is as shown in Fig. 10. It consists of a metal vessel V with plate glass windows inside which is mounted a silver cylinder C whose windows are inclined at 107°. When the silver cylinder and outer metal vessel are filled with the same liquid, light normally incident is not refracted, but, if the silver cylinder contains a liquid of different refractive index, refraction will occur, The displacement of the image is measured on a scale in the telescope. Provision is made for thermostatting the cell.

An automatic recording differential continuous flow instrument has recently been described by Hilger. In this the sample and reference compartments have inlet and outlet tubes so that, either or both liquids may flow. The cells are constructed so as to prevent either turbulent or stagnant volumes from forming. The instrument gives an electrical output which is linearly proportional to the difference in refractive index. A null-balance system of measurement is used: any change in refractive index unbalances the system; a simple servo mechanism then restores the balance. The output may be recorded, displayed or used to initiate a control system. Variations in the intensity of the source have little effect; the effect of thermal variations is also small. It will operate for long periods without attention. No figures are quoted for the accuracy.

As indicated in Part I, photoelectric methods will eventually supersede visual in optical measurements. Progress in refractometry in this direction has not, however, been so rapid as in other fields.

Applications

Refractometry finds application in many industries, for example, brewing, chemical engineering, confectionery, distilling, effluent control, pharmaceutical, soft drinks and sugar.

Previously, in the research laboratory, refractive index was used as a criterion of purity. In this connection it has now been largely superseded by spectroradiometric techniques. Another obsolescent research use is the calculation of dipole moments from refractive index measurements.

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The Harrison Memorial Prize

The Selection Committee, consisting of the Presidents of The Chemical Society, The Royal Institute of Chemistry, The Society of Chemical Industry, and The Pharmaceutical Society, will, in 1960, consider making an award of the Harrison Memorial Prize.

The prize, which consists of a bronze plaque and a monetary payment of 100 guineas, will be awarded to the chemist of either sex who, being a natural-born British subject and not at the time over 30 years of age, shall, in the opinion of the Selection Committee, during the five years ending December 1, 1959, have conducted the most meritorious and promising original investigations in chemistry and published the results of those investigations in a scientific periodical or periodicals.

Applications, five copies of which must be submitted, should include the full names of the applicant; age (birth certificate to be enclosed); degrees (with name of University); any other qualifications and experience; titles, and reprints if available, of published papers (with co-authors' names); where research was carried out; testimonials and references, and any other relevant particulars.

The Selection Committee is prepared to consider applications, nominations, or information as to candidates who have not attained the age of 30 years at December 1, 1959, and are otherwise eligible for the prize. Any such communication must be received by the President, The Chemical Society, Burlington House, Piccadilly, London, W.1, not later than Thursday, September 1, 1960.

Grants by Paul Instrument Fund Committee

£500, in supplement of a previous grant, to Dr. B. V. Bowden, the Manchester College of Technology, for the development of narrow pass band dye filters.

£545, in supplement of a previous grant, to Dr. R. Feinberg, of the electrical engineering department, Manchester College of Science and Technology, for the construction of an instrument for measuring the intensity of soft X-radiation generated in experimental high voltage valves.

£3,000 to Prof. D. Gabor, professor of applied electron physics at Imperial College, London, and Dr. D. Jones, of the department of electrical engineering, Imperial College, London, for the development of an electron interference microscope.

£8,100 to Dr. H. H. Hopkins, reader in optics, department of physics, Imperial College, London, for the development of methods of drawing and coating fine glass fibres, and their alignment in ordered bundles for the transmission of optical images.

£3,000, in supplement of a previous grant, to Prof. R. O. Redman, professor of astrophysics in the University of Cambridge, for the construction and testing of a thin astronomical mirror of plate glass and of a new type of support system.

£6,000, in supplement of a previous grant, to Dr. C. N. Smyth of University College Hospital Medical School, London, and Mr. F. Y. Poynton of Northampton College of Advanced Technology, London, for the construction of an ultrasonic microscope.

THEORY AND PRACTICE IN THE PHYSICAL CHEMISTRY LABORATORY

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PART V—LABORATORY SUPERVISION

THERE are several essentials in the education of students in a chemistry laboratory. These include good layout, equipment, chemicals, laboratory stewards, and above all the right type of laboratory supervision.

Such supervision will not only be profitable in the training of good scientists, but will also allow assessment of student qualities which neither lecture periods nor examinations can provide. It is proposed therefore to consider the requirements and possibilities of good laboratory supervision.

The primary aim should include the co-ordination and integration of theory and practice in the student's mind and therefore necessitates the giving of correct advice and guidance. The ideal laboratory supervisor should have sound theoretical knowledge, be competent in experimental work, and intellectually a leader in that he should be able to inspire the student to devote a sufficient part of his time to *thinking* about his scientific subjects rather than in attempting to memorize facts and arguments involved in them. He must get on with both staff and students, and his personality must be such as to command not only friendship but also respect. One can almost hear the query: 'How many people are there who fulfil *all* these requirements?' Well, we are considering the *ideal* supervisor.

Experience shows that some supervisors are more theoretically minded, while others are more practically minded. *Extremes* of theoretical mindedness and practical mindedness to the major exclusion of the other are bad. It should be remembered that the essential features of a science subject, as compared with a non-scientific one, are not only its logical approach to a problem (non-scientific subjects also apply logical principles) but also that any scientific assumptions and conclusions should be capable of being tested in the laboratory. It is clear therefore that in science theory is the mother of practice and that its continuance depends on this offspring. On the other hand, the offspring cannot develop without the mother. The experiments demand careful *planning* which is impossible without a good theoretical background. It is wrong in principle, and economically wasteful in practice, to use the experimental period primarily for teaching people 'on the bench'. Such practice increases the student's ability and tendency to play about with chemicals rather than to improve his ability to correlate theoretical knowledge and experimental technique. This cannot be emphasized too often, because a supervisor with almost sole interests or abilities in experimental techniques may, even unintentionally, divert the attention of the student from the main purpose of scientific education, which is correlation and integration of theory and practice. Equally well, supervisors who are sound on the theoretical side but wanting on the practical side do not measure up to the ideal requirements of laboratory supervision, though of course the lead that they may be capable of giving the student on the theoretical side is of fundamental importance.

Can supervisors with extreme tendencies on either side adapt themselves to the general requirements noted above? A great deal depends on the individual, but there are certain considerations which suggest that usually the answer is likely to be negative. To begin with, it is the custom of quite a number of science teachers, whether in colleges or schools, to interpret their function essentially as one of transferers of information. Such habits are difficult to break. The struggle between conscience and ease of operation is not necessarily followed by victory of the former, particularly when there exists the possibility of contesting the interpretation and of altering it somewhat. Further, education and adaptation are speedier, if not easier, where the young are concerned. The older the person, the more fixed do his ideas tend to become. By the time a man becomes a permanent member of staff who supervises the practical periods he is usually in his mid-twenties with more or less generalized ideas which are not necessarily rearrangeable, thus making adaptation less likely.

The difficulty experienced in adjustment in laboratory supervision is by no means uncommon. The appointment of a member of staff often calls for a balanced combination of teaching ability, research ability, personality, good mixing capacity and other qualities. Sometimes, the person appointed leans heavily on one of these required qualities, to the lesser or greater exclusion of others. As is well known, good research ability and good teaching ability do not necessarily run side by side. This can be due to an otherwise capable person not possessing the ability of self expression. It should also be borne in mind that the definition of research *ability* is rather loose. There is fundamental long term research and also the series of routine measurements which are dubbed by the hopeful as 'research'. In fundamental research it is possible and often desirable to employ both inductive and deductive methods. Indeed, many fundamental scientific discoveries have been due not to deductive reasoning but to those flashes of inductive ideas in which the really able research worker abounds. These often do away with the slow and painfully drawn out work which would have

resulted in the investigator being bogged down for years in a non-profitable field, and which might well have caused him to lose faith in the overall research project and even in himself. Such flashes of genius are not part and parcel of teaching; indeed, some might consider them alien to straightforward education. The first-rate investigator, full of new ideas, may well tend to be impatient of the slowness of appreciation of his concepts and may chafe at the slowness of their acceptance by the outer world. As his impatience grows, his effectiveness as a teacher lessens, even if he possesses the ability of self expression. Against this criticism one should take into consideration that, even though this type of lecturer or laboratory supervisor may tend to push forward too fast, he is capable of inspiring his students and making them give their own contributions in the scientific world. Such inspiration is a welcome tonic and should not be spurned.

One factor often required as an adjunct to laboratory supervision is the opportunity to assess the student's capacity and limitations, as well as determination. As is well known, examination results affect a student's future progress considerably. However, the examination system is incapable of assessing the student's level of determination which, if sufficiently high, can become the determining factor in his future. Many examples are known where determination has succeeded despite examination failure or considerable opposition, though fame was sometimes attained only after death. Of the most famous cases one need quote but few, e.g. Abbé Mendel, the father of genetics, Planck and his quantum theory, Einstein in relativity theory, and Lister in antiseptics. One does not expect the student to achieve such heights because of his determination, but obviously an assessment of his determination must be considered side by side with his other abilities so as to be able to assess his potentialities as well as limitations.

The lecture periods do not allow the direct personal contact which is necessary for the assessment of a student's vital personal qualities, such as intellectual ability and outlook on life. The tutorials allow better contact because of the greater opportunity of discussion when smaller numbers of students are involved. But the practical period in which the supervisor has the opportunity of direct personal discussion with the student, can be used for an efficient assessment of the student's qualities.

This close personal contact should enable the supervisor to help the student to appreciate scientific principles to a greater extent than a series of formal lectures. The supervisor should therefore not wait for the student to come up to ask him questions; he should make it his job to approach each one in turn. At first the questions and discussions should centre on the experiment on which the student is engaged. The supervisor should find his weak spots and attempt to fill the empty gaps and to correct any misunderstandings. Thereafter, the discussions may widen so as to gather more information concerning his outlook on scientific problems.

Naturally, the supervisor is bound to encounter students of various categories, and his approach must be adjusted to individual cases. Often problems of discipline are involved. For example, the supervisor may be confronted with the type of 'clever' student who can make himself a nuisance in the lecture room or in the laboratory. What methods can be adopted in dealing with such a student?

There are a number of ways; these depend on the particular lecturer and the particular student. One method, which usually pays dividends, is to await patiently, even though agonizingly, for that great moment when the student can be laughed out of court. This treatment can often be combined with an impressive lesson in scientific principles to the student fraternity. Some experiences may be recounted in this connection.

A capable student was imbued with such a high self-belief that he openly and regularly discounted any help from the laboratory supervisor. One day when he was about to start on the standard experiment on the acid hydrolysis of methylacetate, the demonstrator tried to explain to him the special precautions necessary for obtaining good results. 'Don't bother' said the student in a condescending manner. 'I really don't need any help, since I am quite clear as to what I have to do'. The supervisor moved away resignedly and did not issue the usual advice concerning the type of acid-base indicator required in the titrations, even though he felt certain that the student was likely to make this mistake. The time has come, he felt, to teach this student a lesson. Sure enough, after an hour and a half in which the student carried out four titrations, the student informed the demonstrator that 'there must be something wrong with the experiment, since the titre values have remained constant throughout'. He added that no doubt the distilled water, etc., used in the experiment were not properly prepared by whoever was responsible. The long-suffering lecturer checked the method used by the student and found what he expected, viz. that the student had used methyl orange and not phenolphthalein as the indicator, and proceeded to explain to the *whole* class why phenolphthalein should not be used, emphasizing of course that the students ought to know all about this aspect, as it was quite simple.

Another example, again involving the rate of hydrolysis of methyl acetate, concerns another student who almost invariably scorned the help of the lecturer with the usual condescending attitude typical of such students. The lecturer noticed that he did not borrow a stop-clock and that he did not use a watch. The student was kept under observation for the next two hours. Aware of that, but not of the reason, he worked harder than usual. After two hours, the lecturer remarked to the student—'I notice that you are not timing your measurements. How do you propose to plot your results?' A sudden horror appeared on the face of the student, as the light dawned on him. 'I was beginning to wonder what to do with these results' he stammered.

There was the case of the student who would have tried the patience of an angel by his repeated 'innocent'

questions which were so worded as to cast doubt on the lecturer's accuracy of statement. But even here justice was eventually meted out, to the applause of the whole class. The problem of supercooling was being discussed in relation to equilibrium condition attainment. It was explained that a long time interval was not necessarily the only requisite for the formation of the stable form of ice as water was being cooled past 0 °C. The requirement of the presence of a crystal of ice was emphasized, and it was pointed out that supercooling down to —9 °C. was possible. This was dependent on the absence of vibration since otherwise immediate freezing would result giving rise to a solid mass of ice. The inevitable question from the particular student followed: 'Surely, this is rather too wide a generalization?' 'Surely . . . . .' In a flash, the long-suffering lecturer saw the golden opportunity. 'I am afraid that this is so. For example, if you were to push your finger into well supercooled water it would be surrounded by ice almost immediately. Would you like to try it? Of course, if you are afraid, I can't blame you. It can be quite a shock.' The trap having been sprung, refusal was rather difficult. Needless to say that when the student pushed his hand into the supercooled water, it was covered with ice. The painful look on the student's face and the delighted yells of the student audience were memorable. The student gave no more trouble, and the class had absorbed the knowledge of an outstanding property of supercooled water.

(*To be continued*)

The Polarographic Society

A meeting of the Polarographic Society was held at the Institute of Diseases of the Chest on February 11, 1960. The subject of the meeting was 'The Determination of Oxygen in Biological Systems', and the following papers were read:

D. D. Tyler and F. Holton, M.R.C. Radiobiology Unit, Hammersmith. 'Respiratory measurements with a vibrating unshielded platinum cathode and silver anode; ageing and linearity of response'.

R. E. Steele, B.E.C.C. Radiobiology Unit, Mount Vernon Hospital. 'Difficulties in measuring the partial pressure of oxygen in tissue'.

T. S. Evans and P. S. D. Naylor, Medical Unit, St. Thomas's Hospital. 'Measurement of partial pressure of oxygen in vivo'.

D. L. Dewey, B.E.C.C. Radiobiology Unit, Mount Vernon Hospital. 'Hersch cell'.

N. L. Gregory and J. W. Lightbown, National Institute for Medical Research, Mill Hill. 'The Polarograph for oxygen estimation in respiring biological systems'.

J. H. Glover, British Oxygen Research & Development Ltd., London. 'New method for oxygen analysis'.

I. S. Longmuir, Institute of Diseases of the Chest, Brompton. 'Measurement of partial pressure of oxygen in blood'.

There were 85 members and guests present. In addition to the listed speakers Mr. Donald Cater of Cambridge gave a short contribution on 'The use of solid micro-electrodes in tissue'.

Refreshments were provided, and these were followed by the 5th Annual General Meeting of the Society. The following Officers and Committee were elected:

Chairman: Mrs. B. Lamb

Vice-Chairman: Mr. G. F. Reynolds

Secretary: Mr. J. H. Glover

Treasurer: Mr. D. R. Curry

Committee:

Dr. I. S. Longmuir (Editor)
Mr. G. Russell (Publicity Officer)
Mr. R. Pitches (Journal Business Manager)
Dr. V. S. Griffiths
Dr. G. I. Hills
Mr. K. Baker
Mr. R. E. Coulson
Mr. R. C. Rooney
Mr. R. J. Motz

The Role of Plastics in the Construction of Laboratory Apparatus.

(*Concluded from page* 239)

by unplasticized P.V.C. perforated discs and sintered polythene discs. Regenerants are contained in polythene storage tanks and are fed to the resins by means of plasticized P.V.C. tubing, the flow being controlled by ebonite stopcocks, lubricated with silicone grease. The metal frame work is coated with epoxy resin based paint to protect it from the effect of spillage of regenerant. The quality of the water flowing from the deionizer is monitored by means of a conductivity cell constructed in unplasticized P.V.C. For ultra pure water the effluent from the main unit is passed through a mixed bed ion-exchange unit comprising a nylon coated metal cylinder. Finally polythene tubing is recommended for conveying this high purity water.

Conclusions

In this article an attempt has been made to indicate the more outstanding contributions made by plastics to the development of laboratory apparatus. The list could be considerably extended by including applications met with on plant scale operating; by including items available on the domestic market but which also find application in the laboratory, such as polythene buckets and bowls, boxes and containers; and by including relatively minor applications such as the use of silicones for promoting water repellant surfaces on glassware, greases for glass joints and stopcocks and so on. Plastics is also very evident in the form of safety clothing such as P.V.C. aprons, Terylene overalls and cellulose acetate goggles, and P.V.C. and polythene film and sheet are used in considerable quantities both as sample bags and as instrument covers.

It is hoped that this, of necessity, restricted account will illustrate the tremendous impact that plastics are having in the laboratory field and the considerable contribution that their use is making both to increased efficiency and safer working.

Apparatus for Routine Analysis

by G. Lindley

Works Chemical Laboratory, English Electric Co., Ltd., Bradford

PART V—AN IMPROVED GAS FLOWMETER

Introduction

In constructing a unitized apparatus for the determination of sulphur in iron and steel in the routine section of the laboratory, a gas flowmeter was required which would operate with a minimum of trouble. At the same time a design to accommodate a wide range of gas flow rates was also required for other work. Several types of wide range liquid indicating flowmeters have been described, e.g. by White and Wright (1936) and by Belcher and Wilson (1949), and several are available from laboratory suppliers. However, with these flowmeters, there is often inadequate protection against sudden surges in gas flow rate. When such surges do occur the indicating liquid is often ejected and enters other parts of the apparatus, and even when splash bulbs are incorporated this difficulty can arise. The apparatus must then be disconnected and cleaned and the flowmeter refilled, and the zero re-adjusted. With these points in mind, the flowmeter described below was made, and has given no trouble over several years of daily use.

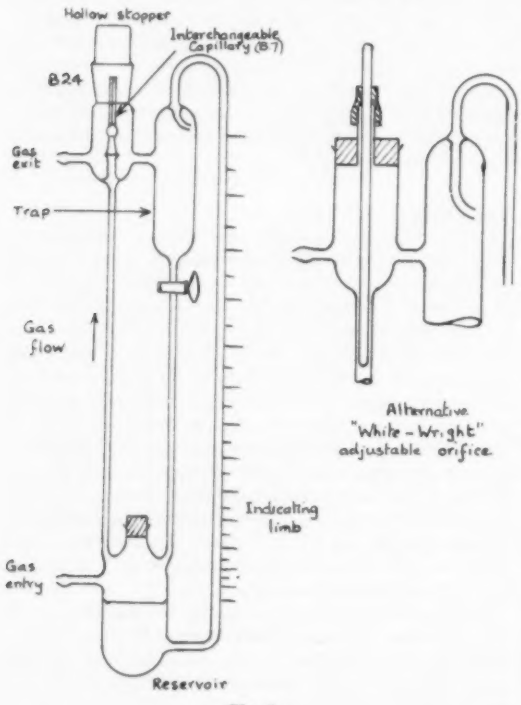

Fig. 1.

Description

The construction of the flowmeter is self evident from Fig. 1, and tubing dimensions suitable for particular applications are used. The trap should have a volume at least equal to the volume of the reservoir, and the indicating limb can be of any convenient length.

In order to allow adjustment for differing flow rates interchangeable capillaries or jets mounted in rubber bungs or in B7 cones can be inserted into the upper vessel. These capillaries are calibrated and the corresponding flow scale is attached to the indicating limb, e.g. by spring clips or by screwing on to a board mount for the whole unit. If required, the upper part of the flowmeter can be constructed to include a 'White-Wright' type of adjustable orifice, instead of a capillary as illustrated.

For operation the reservoir is filled with indicating liquid through the opening shown in the diagram. The scale is then adjusted so that its zero mark corresponds to the meniscus in the indicating limb, and the trap stopcock is closed. By means of a needle valve or other adjustment the gas system enters the flowmeter and the back-pressure resulting from the calibrated capillary causes the liquid to rise in the indicating limb. If a sudden gas surge occurs, the liquid enters the trap and does not contaminate any other part of the apparatus. For re-use it is merely necessary to stop momentarily the gas flow and then open the trap stopcock, when all the liquid is returned to the reservoir and zero is automatically re-established.

This apparatus is now available from Ralph Cuthbert Limited, Westgate, Huddersfield.

ACKNOWLEDGMENT.—*The author is indebted to the English Electric Co., Limited, for permission to publish this paper.*

REFERENCES

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White and Wright. (1936). Canadian Journal of Research, **14B**, 472.

APPARATUS AND DEVICES

It is evident from letters received that the Apparatus and Devices Section of *Laboratory Practice* arouses considerable interest. We should like to point out that we are at all times pleased to receive from readers notes, however short or simple, for inclusion in this section.

THE LABORATORY APPARATUS AND MATERIALS EXHIBITION

June 20 to 23, 1960

THE Laboratory Apparatus and Materials Exhibition, sponsored by this Journal and organized by U.T.P. Exhibitions Ltd., will be held at the Royal Horticultural Society's New Hall, Westminster, London, from June 20 to 23, 1960. This is the first exhibition of its kind to be organized in the United Kingdom on a national scale, where products and materials exhibited are limited to those specially produced for use in all types of laboratories. For the first time, under one roof, practically every possible laboratory requirement will be available for examination, study, comparison and selection.

In addition a comprehensive series of lectures on recent advances in laboratory techniques by specialists in their field will be given throughout the entire run of the Exhibition and the full programme is given below.

Daily glass blowing demonstrations will be given on Stand 67 by Mr. J. A. Frost of the University, Reading.

Date & Time	*Lecturer*	*Subject*	*Chairman*
June 20, 1960			
10.00 a.m.	F. P. W. Winteringham, F.R.I.C.	'The Labelled Pool Technique in Biology'	Prof. A. Wormall, D.Sc., F.R.S.
11.30 a.m.	Prof. R. Belcher, D.Sc., Ph.D., F.R.I.C.	'Indicators'	Prof. F. C. Tompkins, D.Sc., F.R.S.
3.00 p.m.	J. E. Salmon, Ph.D., B.Sc., F.R.I.C.	'Ion Exchange Techniques'	Prof. D. P. Craig, D.Sc.
June 21, 1960			
10.00 a.m.	J. Hetman, F.R.I.C.	'Polarography in the Food and Beverage Industries'	J. D. Mounfield, Ph.D., F.R.I.C.
11.30 a.m.	Prof. R. W. Douglas, D.Sc., F.Inst.P.	'Glass as a Laboratory Material'	Prof. S. Tolansky, D.Sc., F.R.S.
3.00 p.m.	G. W. Scott-Blair, M.A., D.Sc., Ph.D., F.Inst.P., F.R.I.C.	'Rheology'	Prof. G. I. Finch, M.B.E., D.Tech., F.R.S.
June 22, 1960			
10.00 a.m.	A. E. Saunders-Singer	'Micrurgy. Devices and Techniques in Biology and other Sciences'	E. Hindle, M.A., Sc.D., F.R.S.
11.30 a.m.	M. A. Fill, F.R.I.C.	'Small Scale Manipulation'	J. G. Davis, D.Sc., Ph.D., F.R.I.C.
3.00 p.m.	A. T. James, Ph.D.	'Gas Chromatography'	Prof. H. D. Kay, C.B.E., D.Sc., F.R.S.
June 23, 1960			
10.00 a.m.	A. D. Booth, D.Sc.	'Laboratory Computers'	Prof. J. D. Bernal, M.A., F.R.S.
11.30 a.m.	Prof. E. J. King, D.Sc., Ph.D., F.R.I.C.	'Clinical Biochemistry'	Sir Charles Dodds, M.V.O., M.D., D.Sc., F.R.C.P., F.R.S.
3.00 p.m.	Surgeon Commander H. M. Darlow, R.N.(Retd.), B.A., M.R.C.S., L.R.C.P.	'Safety Techniques in the Microbiological Laboratory'	Prof. A. A. Miles, C.B.E., M.D., F.R.C.P.

'CONSORT'

A New British Research Reactor Proposed

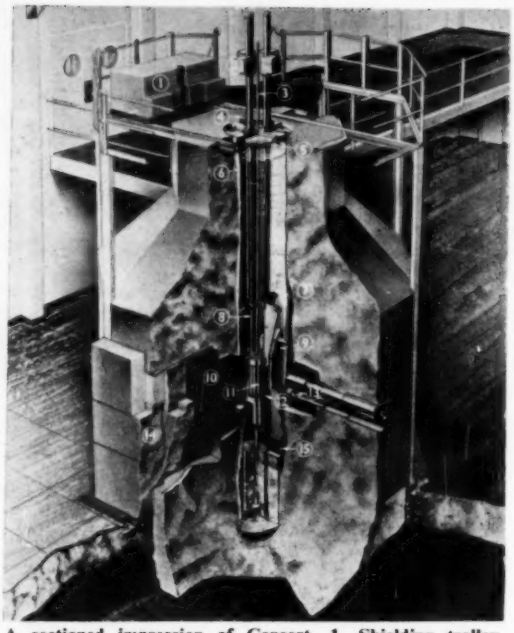
Installation at Imperial College

A NEW low-priced design of nuclear research reactor is to be marketed by G.E.C. This reactor, Consort, is one of an inherently safe type, using ordinary water as both moderator and coolant. It has been designed jointly by the G.E.C.—Simon-Carves Atomic Energy Group and the nuclear power group at the Imperial College of Science and Technology, London University. This collaborative approach has resulted in a design particularly suitable to meet the specialized research and training requirements of universities and colleges in any part of the world. At the present time, Consort is the only completely British designed research reactor in the 10 kilowatt range.

The design was originally produced for the proposed installation to be operated by the nuclear power group of Imperial College, under the leadership of Prof. J. M. Kay, at a convenient site outside London. This proposal, which is an integral part of the College's programme for the expansion of its nuclear engineering training and research facilities, has been approved in principle but at present awaits financial sanction before an order can be placed with G.E.C. The cost of the reactor is approximately £50,000.

The new reactor was designed with a view to combining some of the principal advantages of the two well-known existing types of water-moderated research reactors, the 'swimming-pool' type and the 'enclosed-tank' type. In the former design, the reactor core is housed in a large tank of water at a substantial depth below the surface so that the water itself provides all the shielding necessary above the core. This arrangement offers the advantages of good accessibility and ease of handling of the fuel elements. The enclosed-tank reactor uses a comparatively small tank of water with concrete shielding above the core as well as round the sides. The whole assembly is more compact than the swimming-pool type with the result that it is much easier to locate external experimental assemblies close to the core itself. On the other hand, a relatively complex fuel-handling system is required.

Consort provides a most effective compromise between these designs, combining ease of fuel-handling with compactness and good accessibility to the core for experimental facilities. The core is located only 10 ft. below the surface of the water moderator in an open-topped tank, but additional shielding is provided in the form of movable concrete-filled trolleys which cover the top of the tank while the reactor is in operation. It has been possible to incorporate an experimental 'bare face', protected by portable shielding blocks, closely adjacent to the reactor core, a most important facility for research and training purposes. When the reactor is shut down, the shielding trolleys can be withdrawn and manipulation of the fuel elements can then be carried out beneath the water, under direct observation by the operator using simple manual techniques. Furthermore, the whole design is based on the use of a well-proved type of enriched-uranium-alloy fuel element which is readily obtainable from the United Kingdom Atomic Energy Authority as a standard production item.



A sectioned impression of Consort. 1. Shielding trolley. 2. Control rod mechanism. 3. Vertical experimental tube. 4. Channel for water connections. 5. Perspex dust cover. 6. Tank. 7. Biological shield. 8. Control rod. 9. Experimental face. 10. Thermal column. 11. Fuel elements. 12. Core support plate. 13. Flux measuring instruments. 14. Concrete shielding blocks. 15. Shielding plugs for element storage holes.

Experimental Facilities

The new reactor has been designed primarily as a source of neutrons for use in experimental work for research and training purposes. The rating of the Imperial College design for continuous operation is 10 kW. and, at this power level, a flux of approximately 3×10^{10} thermal neutrons and 2×10^{10} fast neutrons/cm.^{2} sec. is available at an experimental face in the wall of the reactor tank adjacent to the core. A similar flux can also be obtained at the inner face of a graphite thermal column on the opposite side of the tank.

The bare experimental face is a particularly versatile facility. It allows experimental assemblies to be built very close to the reactor core, thus providing them with a high neutron input. If it is desired to feed a vertical beam of neutrons to an experimental assembly, as may be convenient with water-moderated systems, this can be achieved by means of a dual-purpose thermal column, available as an optional extra. This consists of a horizontal column of graphite built against the bare face and having a vertical stub at its outer end. By means of suitable voids in the graphite the neutron flux at the end of the stub may be optimized for both strength and distribution. The dual-purpose column may at the same time be used to provide a horizontal beam of neutrons if required.

Other experimental facilities can be provided in the form of one or more beam tubes issuing radially from the reactor tank at core level while a vertical tube through the centre of the reactor core permits the cycling of specimens into and out of the central flux of 4×10^{11} fast and 2×10^{11} thermal neutrons/cm^2. sec.

Reactor Core

The core of the reactor is built up from between 20 and 24 fuel elements of the standard M.T.R. type in which the enriched uranium-aluminium-alloy fuel is fabricated in the form of slightly curved plates clad in aluminium. A number of these plates are assembled to form an approximately square-sectioned element such that the coolant can flow between the faces of adjacent plates.

The fuel elements are arranged vertically to form an approximately cylindrical core, each element being located at its lower end by a spigot which engages in a hole in an aluminium support plate. A hole through the spigot permits the water coolant to flow upwards between the fuel plates.

Below the level of the core within the reactor tank, shielded fuel-element storage holes are provided, each fitted with a removable stainless-steel shielding plug. These compartments can accommodate a full charge of 24 fuel elements. The design of the storage area is such that there is no possibility of inadvertently assembling a critical mass of fuel. The shielding of the holes is adequate to permit direct access to the experimental face and the thermal column one day after the reactor has been shut down.

Reactor Structure

The core, with its support structure, is mounted near the bottom of a vertical cylindrical tank filled with water to act as moderator, coolant and shield. The tank, which is made of high-purity aluminium, ¼ in. thick, is open at the top, but a Perspex cover keeps the water surface free of dust. Provision is made for the dispersal of hydrogen evolved in the moderator during operation of the reactor and also for the detection and collection of fission products in the event of a fuel-element failure.

In the vicinity of the core, two rectangular flat surfaces are provided in opposite walls of the tank to accommodate the experimental face and the thermal column. At the same level, the beam tubes project into the tank through tube stubs which are welded to the tank wall and blanked off at their inner ends.

The tank is surrounded by a concrete biological shield, octagonal in plan, with a thickness of approximately 7 ft. 6 in. reducing to 3 ft. near the top of the tank. The main body of this shield is a monolithic structure, but on two diametrically opposite faces, removable concrete blocks are employed so as to permit the necessary flexibility in the disposition of shielding around experimental assemblies set up adjacent to the experimental face and the thermal column. This arrangement also provides a means of access to the experimental facilities after the reactor has been shut down. It is important to ensure that such access is not prevented by the presence of dangerously high levels of radiation arising from neutron-activation of the concrete, and for this reason a sheet of cadmium is interposed between the concrete and the tank wall in the vicinity of the experimental facilities. The activation of steel structural members in this area is also reduced by the application of a cadmium coating.

Axial shielding above the core consists of a 10 ft. depth of water which is supplemented, while the reactor is in operation, by a 2 ft. 6 in. thickness of concrete. This concrete shielding takes the form of two movable trolleys which run on guides set in the top face of the reactor structure, the joint between the trolleys being stepped and shaped to fit around the control rod support tubes. The trolleys are moved by hand, and interlock limit switches are fitted both at the fully open and at the closed position.

Control and Instrumentation

The reactor is controlled by means of vertical neutron-absorbing rods which are of flat section and pass through guide tubes between adjacent fuel elements. There are two shut-down rods, one fine control rod and one safety rod. All these rods are raised and lowered in their guides by means of driving mechanisms mounted above the reactor.

Two alternative types of control-rod mechanisms are available for this reactor. In one design, the upper end of each rod is coupled, by means of an electromagnet, to a vertical rack moving between guide rollers. The rack is driven by a squirrel-cage induction motor through a gear-train from which the drive to the magslip rod-position indicator is also taken. If an emergency should arise, the electromagnets are automatically de-energized, thus releasing the rods from the racks and allowing them to fall into the core under gravity.

In the alternative arrangement, each rod is supported by a stainless-steel wire rope which passes over a pulley vertically above the rod and is then wound round a driving pulley mounted at the edge of the biological shield. This pulley is driven by a small geared motor through an electromagnetic clutch which, under 'scram' conditions, is automatically released so that the rod falls into the core.

The instruments required for the measurement of flux and other control functions are mounted in shielded holes close to the wall of the reactor tank, the necessary connections being carried in tubes passing through the biological shield. The control equipment and instrumentation needed for operation of the reactor are housed in panels in a separate control room.

Fuel Handling

The fuel-handling arrangements are such that, once the reactor has been shut down and the shielding trolleys withdrawn, fuel elements can be transferred between the core and the storage holes in complete safety by means of a simple manual operation. The handling tool consists of a long tube with a grab-head at its lower end and release levers at the top. The jaws of the grab are shaped so that an element cannot be released until its weight is fully supported either in one of the storage holes or by the core-support plate. Furthermore, the tool is designed to limit the height to which an element can be raised above the core, thus ensuring that the operator is always shielded from radiation by an adequate depth of water.

Water Circuit

The water connexions to the reactor, comprising inlet, outlet, and overflow pipes, enter the tank through the top.

On leaving the reactor, the water is pumped through an external circuit by means of a motor-driven pump capable of handling 400 gallons per hour. The main circuit includes filters for the removal of any entrained solid particles, and a cooler which is controlled to ensure that the water-temperature at inlet to the reactor core is kept at a steady value. The water is maintained at the required degree of purity by continually diverting 10 per cent of the main flow through a water-treatment plant.

All the equipment associated with the water circuit is housed in a plant room adjacent to the reactor. A dump tank, installed below ground-level in a shielded pit, is used for holding any active effluents from the water-treatment plant pending their disposal, and it can also, in an emergency, accept the whole of the water in the reactor circuit.

TRITIUM-LABELLED SUGARS FOR TRACER RESEARCH

SUGARS and sugar derivatives having tritium—the radioactive isotope of hydrogen—substituted for hydrogen in a specific site within the molecule are being prepared by the National Bureau of Standards in a project sponsored by the Division of Research of the Atomic Energy Commission. At present, all of the common sugars labelled with tritium at carbon 1 are available for distribution to other laboratories.[1] These sugars, identical with ordinary sugars except for the radioactive tritium atom, should prove to be a valuable tool in tracer research on chemical, medical and biological problems.

Methods of analysis and multipurpose equipment which facilitate chemical application of tritium, as well as practical procedures for the synthesis of tritiated carbohydrates, have been designed. These developments are part of a broad research programme on radioactive carbohydrates[2] now being conducted by Dr. H. S. Isbell and associates of the Bureau's organic chemistry laboratories. One phase of this programme, initiated in 1950, has made possible the synthesis and distribution of a wide variety of carbon-14-labelled carbohydrates[3] to research workers in other laboratories.

Tritium is one of the products from nuclear reactors. It has a combination of properties that makes it an extremely versatile research tool. Although it is highly radioactive, its low-energy beta radiation is so weak that it can be blocked by a sheet of paper. Thus, when tritium is incorporated in non-volatile materials, it presents little or no radiation hazard, and is relatively safe to use. One of the cheapest radioisotopes (only one eleven-thousandth as expensive as carbon-14), tritium can be detected in extremely small quantities by means of its radiation. As little as one-billionth of a milligram of tritium oxide (tritiated water) can be readily measured.

Because tritium is the radioactive isotope of hydrogen—a constituent of nearly all organic compounds—and enters into the same chemical reactions as hydrogen, its possible uses and applications in organic and biological chemistry are practically unlimited.[4] In the form of tritiated water or other tritiated reagents, tritium can react with a wide variety of organic compounds. Thus, a few tritiated starting materials enable the chemist to prepare numerous radioactive compounds for use in chemical and biological studies. Once incorporated in a stable molecule in place of hydrogen, the isotope serves as a 'tag' that can be used to trace the course of an atom or a molecule through an entire series of complex chemical and physical processes.

Despite these advantages, tritium's widespread use has been hampered by lack of convenient methods of analysis. If a radioisotope is to have maximum usefulness in chemical and biological studies it must be possible to measure its radioactivity rapidly and simply. Analytical methods for tritium, such as the counting of gaseous samples in ionization chambers or dissolved samples in liquid scintillation counters, are time-consuming and require elaborate equipment.

Analytical Method

The Bureau has now developed a practicable method[5] for the routine analysis of tritium in water-soluble, non-volatile materials. In this method, the radiation from a tritium compound, which is incorporated in a film, is measured in a 'proportional counter'. Because of its simplicity, the method should make possible numerous procedures employing tritium as an analytical reagent.

In the first step of the analysis, the radioactive substance is combined with a water solution of a thickening agent (preferably carboxymethylcellulose). This radioactive mixture, on a counting plate, is then converted to a film by evaporating the water. The radiation from the film is measured in the windowless, gas-flow, proportional counter, which is available in most laboratories where radioactive materials are used. The amount of radioactivity is easily calculated from the net count, the weight of the film, and an empirical constant determined with a substance of known radioactivity.

The radioactive film, though very thin, is 'infinitely thick' to the weak radiation from tritium. That is, the radiation from the lower part of the film is completely absorbed, and a constant proportion from the upper part emerges into the sensitive counting area of the proportional counter.

The presence of the thickening agent has two effects: it promotes formation of a uniform film, and it prevents the radioactive substance from crystallizing on the counting plate—a process that can lead to errors in measurement, or even to radioactive contamination of the counter.

Closed-System Apparatus

Because tritium is a gas and must therefore be used in closed systems, the development of a general-purpose, closed-system apparatus for conducting a variety of operations[6] was one of the first considerations in the Bureau's tritium programme. To this end, improved procedures and special techniques were worked out for such operations as filtration and crystallization within a vacuum system. The essential feature of the resulting apparatus is a vacuum manifold—a central glass vacuum line—to which numerous pieces of specialized apparatus can be attached as needed. By inter-

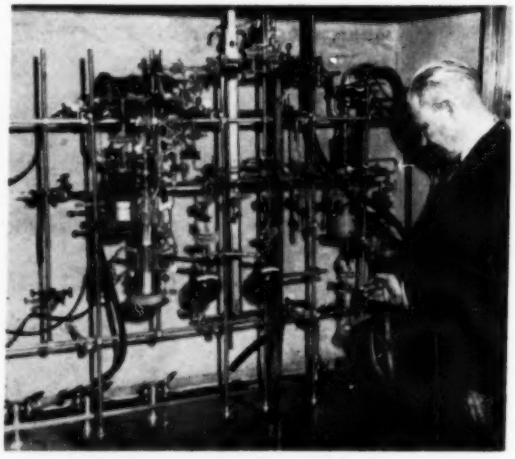


Fig. 1. General-purpose manifold for handling tritium in a closed system. By attaching and interchanging specialized equipment to the manifold (indicated by arrow) many different types of operations can be conducted. Here a reagent is introduced to begin a synthesis.

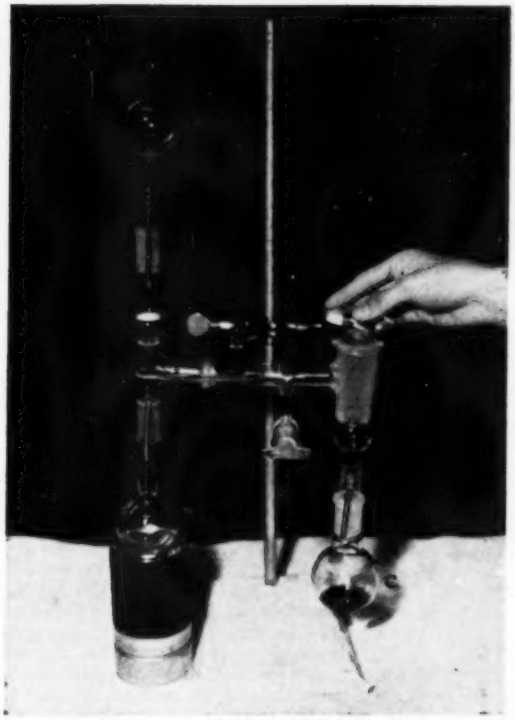


Fig. 2. Apparatus for filtering and recrystallizing tritiated compounds in a small closed system, as designed by the National Bureau of Standards. At the start of the purification process, flask C contains a solvent, and flask A (which is initially in the lower position), contains the solid to be recrystallized. The solvent is distilled from C to A and the solid is dissolved. Then A and B are rotated through 180°, flask B is cooled (as shown) and the solution is filtered through a fritted glass disc into B.

changing the connections, various operations can be conducted in the one composite apparatus.

Because tritium in high concentration decomposes organic compounds by the energy of its radiation, it is frequently diluted with hydrogen before use. The apparatus provides a convenient method for making such dilutions, as well as for removing samples of gas for radioactivity determinations, and for circulating tritiated hydrogen in such procedures as catalytic reductions. The gas is circulated by a gas-transfer pump containing mercury (Toepler pump).

Two important tritium reagents, tritiated water (tritium oxide) and tritiated lithium borohydride, can be synthesized in this apparatus. As both of these compounds have readily available tritium, they are used to introduce tritium into organic compounds, and to synthesize tritiated materials. To prepare tritiated water, tritium gas is passed from a gas burette through a copper oxide furnace heated at 500°C. The tritiated water that forms is collected in a water-trap cooled in a freezing mixture. Finally, the trap containing the tritiated water is isolated, and the water is stored until needed.

Tritiated water can be used to study such practical problems as humidity control, adsorption of moisture in materials of all types, permeability of films to moisture, formation of hydrates and a variety of other chemical reactions that involve water.

Tritiated lithium borohydride, another versatile tritium reagent, is prepared from lithium borohydride and tritium gas. First lithium borohydride is converted to a fluffy, porous form suitable for tritium exchange. To accomplish this, commercial lithium borohydride is dissolved in a solvent, the solution is filtered, and the solvent is removed by 'freeze-drying' (low-temperature vacuum drying). This entire operation is conducted in the closed system because lithium borohydride reacts rapidly with the moisture of the air. The finely divided powder is then heated with tritium gas at 200°C. At this temperature, tritium-hydrogen exchange occurs, yielding the tritiated lithium borohydride. The excess tritium-hydrogen mixture may be stored in a flask for future use, or converted to tritiated water in the copper-oxide furnace. Numerous other reactions and processes, including syntheses of tritium-labelled carbohydrates, can be conveniently carried out with the same apparatus.

Syntheses

One of the objects of the Bureau's programme on chemical applications of tritium is to develop methods for the synthesis of carbohydrates position-labelled with tritium. In general, the synthesis of each substance presents problems of its own, and separate syntheses must be developed for each different position-labelled version of the same compound.

Glucose having tritium attached to carbon 1 is prepared by the reaction of gluconic lactone with tritium-labelled borohydride in the general-purpose apparatus. The reaction can be carried out conveniently by using a hypodermic syringe to inject the sugar, through a rubber stopper, into a flask containing lithium borohydride-*t* in dry tetrahydrofuran. When the reaction is completed excess borohydride is decomposed by injecting a small amount of dilute acetic acid into the flask, and the excess tritium-hydrogen is removed by the Toepler pump. The flask is then removed from the apparatus, and the tritium-labelled glucose is purified by passing the glucose solution through an ion-exchange column and repeatedly concentrating a methanol solution of the glucose to dryness. After this treatment, the glucose-1-*t* is further purified by recrystallization.

As glucose is biologically the most important of the simple sugars, the Bureau is now developing methods for synthesizing glucose labelled with tritium at each of the six carbon atoms. Other sugars and sugar derivatives will be prepared as synthetic methods are developed. Although several methods of synthesis are possible for each labelled sugar, the Bureau is seeking methods that produce the highest yields in the shortest time.

In addition to position-labelled simple sugars, other potentially useful tritium-labelled materials, such as tritiated inulin, are being made. Used clinically for many years to study kidney function, inulin is injected into the blood stream, and its elimination in the urine is measured. Determination of inulin by chemical analysis is laborious but can be avoided by using C-14-labelled inulin (a substance previously prepared by the Bureau)[7] and determining its elimination by means of radioactivity measurements of the urine. A new tritiated form of inulin, considerably cheaper than the corresponding C-14-labelled product, may prove to be an even better material for the study of kidney function.

Study of Isotope Effects

One advantage of using an isotope in research is that its physical and chemical behaviour is very similar to that of the common form of the element. However, an isotope is not identical in behaviour to the common form. For example, there are slight differences in rates of reaction between ordinary carbon and carbon-14, and larger differences in rates between ordinary hydrogen and tritium because tritium is three times as heavy as hydrogen. The rate difference is detectable chiefly when a chemical reaction takes place at the site of an isotope bond. If the isotope is located elsewhere in the molecule, it has little effect on the rate of reaction.

Unless this difference in behaviour can be predicted, it may limit certain uses of isotopes. For example, in locating the position of a radioactive atom within a molecule, the compound is broken into several simpler ones by using oxidizing agents. By the specific activity of the fragments produced, the location of the radioactive atom can be detected. If the radioactive molecule should degrade at a different rate than the non-radioactive form, the results and conclusions drawn from the degradation study would be misleading.

Although an isotope effect is disadvantageous for some purposes, it may furnish data on the course of a reaction by indicating whether an isotope bond is involved. Employing tritium-labelled materials, the Bureau is studying the mechanism of such reactions as the reduction of lactones, and the oxidation of sugars with bromine, chlorous acid, and oxygen. Use of tritiated compounds in these and other reactions should supply detailed information on reaction mechanisms.

A reaction uniquely suited to the study of the isotope effect is being carried out with various carbon-14- or tritium-labelled forms of a six-carbon carbohydrate derivative, D-mannitol. When this compound is oxidized by the micro-organism, *Acetobacter suboxydans*, it yields the sugar, D-fructose. D-Mannitol is a substance in which the two halves of the molecule are alike, so that the enzymes created by *A. suboxydans* have a choice of two suitable sites for oxidation: carbon 2 or carbon 5. In a position-labelled D-mannitol, one half of the molecule contains a radioactive isotope. If its presence does not influence the rate of oxidation, then the resulting D-fructose must have radioactivity equally divided between the two halves. The results of the study show[8] that there is no isotope effect in the oxidation of D-mannitol-1-C^{14}, but that there is a small effect (about 3 per cent) in the oxidation of D-mannitol-2-C^{14}. Studies of an isotope effect in the oxidation of D-mannitol-3-C^{14} and of the various tritium-labelled D-mannitols are in progress. The results will aid in the interpretation of the mechanism of enzymic oxidation by *A. suboxydans*.

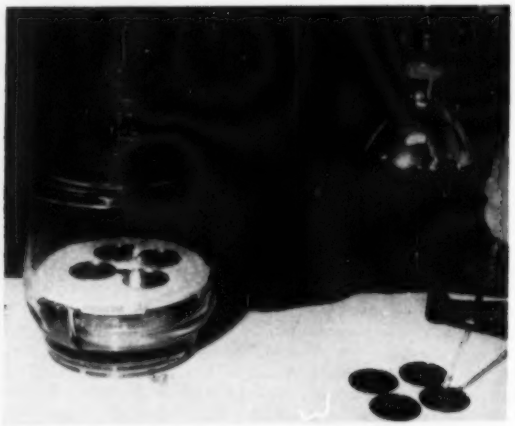


Fig. 3. Sensitive method developed by the National Bureau of Standards for quantitative determination of tritium content. The sample in a carboxymethylcellulose solution is converted to a film under infrared light (*right*). After this radioactive film has been conditioned at controlled humidity (*left*), it is assayed in a windowless proportional counter.

Tritiated Reagents

Part of the Bureau's programme on chemical applications of tritium will be devoted to the synthesis and use of tritiated reagents. It is believed that these compounds offer a vast opportunity for research on analytical methods, structural studies, and reaction mechanisms. In connection with the carbon-14 programme, a procedure has been developed for conducting methylations with C^{14}-labelled methyl iodide.[9] Tritiated methyl iodide will be similarly employed. Reduction with tritiated lithium borohydride, following oxidation procedures, provides an excellent method for introducing a radioactive label at a specific point in a molecule. Wherever a carbonyl group (carbon doubly-bonded to oxygen) can be formed in a molecule, tritium can be introduced by reaction with tritiated lithium borohydride. This technique provides a means for locating the oxidation sites, *i.e.* the critical points at which oxidation has taken place in a molecule. Studies utilizing the technique will aid in solving such technological problems as the determination of the chemical changes in cellulose fibres caused by bleaching agents, air, light, or ageing.

The Bureau has in progress numerous other research projects on tritium and its applications. The direction of the programme will be determined, to some extent, by the needs of other research workers. As in the programme on carbon-14-labelled carbohydrates, it is believed that the tritium work will greatly facilitate the work of other laboratories and contribute fundamentally to the application of radioactive isotopes in organic and analytical chemistry.

REFERENCES

[1]Tritiated sugars may be obtained by purchase order to the National Bureau of Standards, Washington 25, D.C. They are priced at $10·00 per 100 microcuries.

[2]A complete list of the Bureau's publications and patents on this project will be furnished on request to the Organic Chemistry Section, National Bureau of Standards.

[3]Position-labelled radioactive sugars. (1952). NBS Tech. News Bul., **36**, 56.

[4]Use of carbon-14 and tritium for the study and characterization of cellulose and other polysaccharides, H. S. Isbell, H. L. Frush, and J. D. Moyer, (1957). Tappi, **40**, 739; AEC Report No. NBS-4967.

[5]Tritium-labelled compounds. I. Radioassay of tritium-labelled compounds in 'infinitely thick' films with a windowless, gas-flow, proportional counter, H. S. Isbell, H. L. Frush and R. Peterson (in press). J. Research NBS.

[6]Tritium-labelled compounds. II. General-purpose apparatus, and procedures for the preparation, analysis, and use of tritium oxide and tritium-labelled lithium borohydride, H. S. Isbell and J. D. Moyer (in press). J. Research NBS.

[7]Process for labelling polysaccharides with C^{14} and products resulting therefrom, H. S. Isbell, U.S. Patent No. 2,653, 931, Sept. 29, 1953. Carbon-14 carboxy-labelled polysaccharides, J. D. Moyer and H. S. Isbell (1958). J. Research NBS, 61, 71, RP2886.

[8]Isotope effect in oxidation of D-Mannitol-2-C^{14} by *Acetobacter suboxydans*, H. L. Frush and L. J. Tregoning (1958). Science, **128**, 597.

[9]Micromethylation of polysaccharides, H. S. Isbell, H. L. Frush, B. H. Bruckner, G. N Kowkabany, and G. Wampler (1957). Anal. Chem., **29**, 1923; AEC Report No. NBS-4929.

News from the British Association of Chemists

Section Programmes

London

The Section's 42nd Annual Meeting will be held on Wednesday, April 27, 1960 at 7 p.m. at The Station Hotel, Barking, Essex.

After the meeting there will be a supper at which members' ladies and guests will be welcome.

Liverpool

The Annual Meeting of the Section will be held on Wednesday, April 27, 1960.

Birmingham and West Midlands

A visit to the I.C.I. Salt Division Works at Stoke Prior, Worcestershire has been arranged for April 13, 1960.

The Section's Annual Film Show was held at the College of Technology, Gosta Green in February, when the following films were shown:

'Steel' (British Council)
'Man-Made Rubber' (Dunlop Rubber Co.)
'Forming Metals' (Shell-Mex)
'Natural or Synthetic?' (Dunlop Rubber Co.)
'Panorama No. 11' (I.C.I.)

Yorkshire

The Section held a Scientific Film show at Huddersfield College of Technology in January. The films shown were:

Fenhurst Research Station (I.C.I.)
Radio-isotopes in Industry (U.K.A.E.A.)
A topical film (Aluminium Development Co.)

Organization of Chemists in Canada

One of our members, resident in Ontario, has sent us a draft of an Act put before the Provincial Parliament which is entitled 'An Act to Incorporate The Ontario Professional Chemists Association'. Our member says that . . . 'the Act, if passed, will put chemists on a par with doctors, lawyers, pharmacists, etc. It will end the traditional freedom of scientists and this fact has been a hotly debated point. But the reason behindthis is not, as it may appear, to regiment chemists, but to give protection to members. Trades Unions over here are far more militant than those in the U.K. and they are moving into salaried fields.'

The draft Act seeks to restrict the practice of chemistry in Ontario to members of the Ontario Professional Chemists Association or persons licensed by it. It provides for penalties, both fines and/or imprisonment for those who, not being members of the Association or licensed by it, engage 'in the practice of professional chemistry' or use the title of 'professional chemist' in any way. The Act defines 'professional chemist' as any person who practises 'professional chemistry'. This is defined as 'the practising for hire, gain or hope of reward of any branch of chemistry, including, but without limiting the generality of the foregoing, organic, inorganic, metallurgical, biological and analytical chemistry'. The Act, however, excludes from its scope bacteriologists, geologists, mineralogists and physicists, as well as chemistry teachers and those performing duties in Her Majesty's Armed Forces.

The qualifications for membership include:—the passing of the Association's own examinations, residence in Ontario, five or more years of practice in the profession of chemistry and good character. Provision is made, however, for exemption from the examinations and part or the whole of the five years period of practice in the case of those holding recognized degrees, etc. There is also provision for this exemption in the case of members of other approved Associations of Chemists in the Commonwealth and U.S.A. who have the necessary residential qualifications.

The Act provides for the management of the affairs of the Association by a Council of 11 members, two Councillors appointed by the Lieutenant-Governor in Council, the others by the members of the Association. Licences to practice professional chemistry may be given by the Association to members of similar bodies in other parts of Canada and also to those not resident in Canada, who in the opinion of the Council, are recognized as consulting specialists, etc.

The Council may make By-Laws for the purpose of conducting the affairs of the Association, but these require to be approved by two-thirds of the votes cast at a General Meeting called for the purpose and a certified copy shall be filed with the Lieutenant-Governor.

Among the examples of matters to be dealt with in this manner are the regulation of the professional conduct of members and licences and the prescribing of a code of ethics to govern their discipline, conduct, etc. Another interesting point is the 'remuneration and reimbursement' of members of the Council.

These steps which have been taken by chemists in Ontario are yet another example of the gradually increasing awareness, by professional men, of the necessity of combining together for the purpose of protecting their economic interests. The B.A.C. has been preaching this gospel for a number of years and has itself become associated with F.I.C.C.I.A., the International Chemists Association, to this end. One of the difficulties to be overcome is the innate conservativeness of the professional man and his dislike of becoming associated with any form of 'trade unionism'. In other parts of the world they have 'seen the red light' and it now remains for those in this country to follow suit.

Proposed New Institute of Chemical Technology

The matter of an additional grade of membership of the Royal Institute of Chemistry raised at the meeting of representatives of Technical Colleges at Crewe on October 17, 1959, which was sponsored by members of the B.A.C., has been carefully considered by the Professional Status Committee and the Study Group on Qualifications of the Royal Institute of Chemistry. Recommendations were made to their Council in February.

The Royal Institute of Chemistry hopes to reach a final decision, on whether to introduce a third permanent grade of membership, by April 1960.

In the meantime the Steering Committee appointed at the Crewe meeting are taking no further action.

Life Members

The following have been elected Life Members:

A. Andrewartha. Elected 1918/19. London.

N. R. Bogg. Elected 1924. Manchester.

W. Guider. Elected 1933. Manchester.

A. Kagan. Elected 1923. London.

G. E. Smith. Elected 1921. London.

A. R. Taylor. Elected 1922. London.

Miss A. S. White. Elected 1918. London.

A. Womersley. Elected 1947. London.

A. J. Crochatt. Elected 1918/19. London.

W. Kay. Elected 1924. Manchester.

P. Meyer. Elected 1933. London.

R. S. Parker. Elected 1939. Manchester.

V. J. Potter. Elected 1949. London.

J. H. Nutland. Elected Member 1925. London Section.

J. Sowler. Elected Member 1921. Liverpool Section.

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nomination Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

Laboratory Note-Book

A TEAM of scientists in the Nuclear Physics Division at the Atomic Energy Research Establishment, Harwell, using gamma rays from a source of radioactive iron, have completed two ingenious experiments which appear to confirm a basic premise of Einstein's General Theory of Relativity. Their report was given at a meeting of the American Physical Society in New York.

The Harwell experiments were planned by Dr. T. E. Cranshaw (37) of Southport, Lancs, and Dr. J. P. Schiffer (29) an American who is spending a year at Harwell under a Guggenheim Fellowship. Their collaborators were Dr. A. B. Whitehead, a Canadian, who holds an appointment as a Research Fellow at Harwell, and Dr. H. J. Hay from New Zealand, a member of the Harwell staff.

Ever since Einstein announced his general theory of relativity in the earlier part of the century, scientists have looked for evidence confirming his predictions. One such prediction is the so-called 'red-shift' (when light passes out from the gravitational field of a star it suffers an increase in wavelength, i.e. its colour becomes redder—hence the term red shift) arising from the effect of gravity on light and all other forms of electromagnetic radiation. Light from the sun and other stars has been examined for evidence of the red shift but the results have not been clear cut and it is generally agreed that the evidence from astronomical measurements is ambiguous.

In the first of the Harwell experiments the team of scientists used electromagnetic radiation in the form of gamma rays produced by a radioactive isotope of iron. These have the advantage of having an extremely precise wavelength and can therefore serve as a high precision tool. By allowing the gamma rays later to be absorbed by the same isotope of iron, very small changes in the wavelength of the rays can be detected and any shift in wavelength predicted by Einstein, small as it is, would become measurable at heights over 30 ft. approximately in the earth's gravitational field. Using a watertower at Harwell, the three physicists, Dr. Cranshaw, Dr. Schiffer and Dr. Whitehead, arranged for gamma rays from radioactive iron to 'fall' through the earth's gravitational field down an evacuated tube for a distance of 40 ft. The rays were then absorbed in iron of the same nuclear structure as the source. By an ingenious experimental arrangement, careful measurements showed an alteration in the wavelength of the gamma rays close to that predicted by Einstein. As expressed in more scientific terms, the measurements showed that the probability of there being no red shift is less than one part in sixty.

In the second experiment the team sought confirmation of Einstein's prediction that there is no way of detecting any difference between a uniform gravitational field and the force of acceleration. This means that people completely enclosed in a spaceship with no way of obtaining information from the outside could not tell from any measurement made inside the spaceship whether they were sitting at rest in the gravitational field on the surface of a planet or whether their spaceship was accelerating. For this experiment Dr. H. J. Hay, who is experienced with fast rotors, collaborated with the team. The radioactive iron source was placed in the centre of a cylindrical rotor with an absorber of iron of the same nuclear structure located at the outside surface. With the rotor spinning up to 30,000 revolutions per minute, accelerations were obtained up to 65,000 times as large as the acceleration of gravity on the earth's surface. Variation of the number of gamma rays passing through the absorber were observed at different speeds of rotation and the team observed effects consistent with Einstein's prediction.

The radioactive source for these experiments was prepared on the University of Birmingham cyclotron by bombarding an iron target for one hundred hours with a beam of deuterons. The source was purified at the Radiochemical Centre of the U.K.A.E.A. at Amersham. The final processing of both the source and the absorber was performed in the Chemistry Division of A.E.R.E.

Scientists in several other laboratories in England and the U.S. are working on similar experiments independently. The Harwell Group hope to repeat their measurements with greatly improved accuracy in the next few months in order to give added weight to their conclusions.

The British Photobiology Group

A number of British photobiologists decided, in January 1955, to form a group for the purpose of bringing together biologists, chemists and physicists with an interest in this field, to further scientific discussion in this country and to co-operate with similar bodies both at home and abroad. So far the group has held two or three meetings a year and, during the last year, three cyclostyled bulletins have given members news and full reports of the meetings.

During the last year meetings were held at Bedford College, London, at the Marine Biological Association's Laboratory in Plymouth and at the National Physical Laboratory. At these meetings the subjects discussed included the measurement of radiation, luminescence in marine animals and the effect of light on plant and marine life.

This summer the *Comité Internationale de Photobiology* (to which the group is affiliated) is holding its third Congress at Copenhagen in Denmark to celebrate the centenary of Niels Finsen's birth, in acknowledgment of his fundamental work on light therapy. Further information about the British Group, whose Chairman this year is the eminent Oxford physical chemist Dr. E. J. Bowen, F.R.S., can be obtained from the secretary, Dr. Daphne Vince, at the Horticultural Research Laboratories, Shinfield Grange, Shinfield, Reading, Berks.

Cold Cure Volunteers Wanted

Volunteers are still urgently required so that trials at the Common Cold Research Unit, Salisbury, can continue uninterrupted this year.

A short time ago it was announced that this research project had made the most important progress since the Unit was started in 1946. Viruses from common colds have been grown outside the body in cultures of human embryonic kidney cells, an achievement which marks the end of the first long phase of the progress towards the ultimate goal—a cure for the common cold, perhaps the most annoying malady to which mankind is subject. Enough volunteers to continue the research are more essential at this critical phase than ever.

The viruses now described are unlikely to be the agents causing all common colds. It is not yet known whether they even cause a majority of colds; but the way is now open to investigate the question of how many different types of virus there are, and whether different ones prevail in different years as happens with influenza.

None of this could have been found out without the help of the 6,390 volunteers who have visited the unit. For many reasons—not least because there may be other cold viruses waiting to be discovered—volunteers are needed just as much now as before.

These volunteers, of either sex, should be between 18 and 45 years of age, and in normal health. They are required to spend a period of ten days at the Common Cold Research Unit at Harvard Hospital, Salisbury, where comfortable, centrally heated quarters are provided for them. Volunteers are isolated in pairs (or threes) and may come with and be partnered by a friend or friends. Those who come alone will be provided with a partner if they wish. There is ample time for leisure or for study and it is ideal for students who are working for examinations. There is also considerably less than a fifty-fifty chance of catching cold. Fares to and from Salisbury are paid up to £3. 15s. and 3s. a day pocket money is allowed for each volunteer.

A letter or postcard to the Medical Superintendent, Harvard Hospital, Salisbury, will bring full details.

LABORATORY EQUIPMENT & APPLIANCES

New Multiplane Diffractometer

A new multiplane diffractometer for fully automatic or manual operation has been designed and is based on a design currently in use at the Atomic Energy Research Establishment at Harwell.

Apart from its use in the nucleonics field, it is of particular value in the chemical, mining, minerology, semi-conductors, welding and metal industries, and in universities where research in crystal structure analysis is constantly being carried out.

The instrument is economically priced and incorporates goniometric and scanning movements fulfilling the requirements of rapid operation and extreme accuracy. Its weight is approximately 75 lb.

The diffractometer is an x-ray instrument designed to use the Shulz method of determining the preferred orientation of crystals. This method enables the intensities of reflections to be related, without correction, to the number of crystals reflecting. By this method the instrument can be used to examine the crystal structure of a specimen in any plane by the simple but precise adjustment of the goniometer ring.

The setting up of the instrument is rapid and no re-adjustments are needed when the plane of examination is altered. Seven simple adjustments are all that are needed to prepare the instrument for use. (Manufacturers: Seton Creaghe Engineering Ltd., G. W. Trading Estate, Park Royal Road, London, N.W.10.)

The Measuvac McLeod Gauge

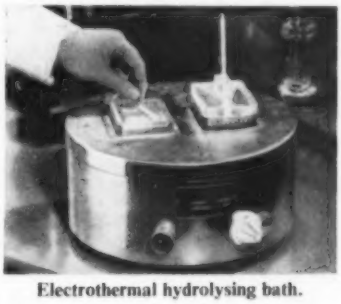
For the first time a McLeod Gauge has been made of very small proportions covering a range of pressure hitherto not possible. This instrument has been designed to meet the increasing demand for a general purpose vacuum gauge giving accurate and rapid pressure readings in all situations calling for a robustly constructed McLeod gauge. It ensures trouble-free operation under the most exacting conditions.

The standard model covers the range from 150 millimetres to 1 micron. This is achieved by the simple operation of depressing a lever which gives accurate readings simultaneously on two scales, one reading from 2 millimetres to 150, and the other 1 micron to 2,000 microns.

On depressing the handle the mercury rises in the three tubes and the rising level in the left-hand intake tube is adjusted to the set mark position. With this held steady a pressure reading is taken on the scale, appropriate to the pressure range. Once the reading has been taken the operating lever is released and the mercury returns automatically to zero ready for the next reading. This eliminates any possibility of mercury being left in the tubes and resultant damage if the pressure should rise to atmosphere.

Unlike most McLeod gauges, the reading capillary tubes are completely separate and easily detachable from the main body by means of the knurled sealing gland. Also, due to the reproducible accuracy between each gauge, replacement scales, glasses or bodies may be made without any calibration and the volume of mercury required for these gauges is not critical. As is common in any type of McLeod gauge where mercury is in contact with glass-work, the surface eventually becomes discoloured and the deposits on the capillary tubes may lead to false readings. The glass-work is easily removed by means of the demountable 'O' ring joints, cleaned in the normal way and replaced again in a very short time. Where necessary the whole mercury tank can be dismantled by means of the four clamping screws and the complete mechanism exposed for this operation. It is necessary to remove the mercury from the gauge before dismantling the tank as described above. (Manufacturers: Genevac Ltd., Pioneer Mills, Radcliffe, Lancs.)

The Measuvac McLeod gauge.



Electrothermal hydrolysing bath.

Hydrolysing Bath

This apparatus has been specially designed to provide easy handling of microscope slides and coverslips during hydrolysis in the Feulgen technique, or any other cytological, physiological, biochemical or histological techniques that require controlled temperatures during staining, etc.

Heating is provided direct to the baths by the system of even heating at the sides and bottom.

Temperature is controlled by a built-in energy controller (for a.c. only) which is fitted with an arbitrary scale. The maximum input is 60 W. and an indicator lamp is fitted.

Two glass stain baths are provided and the apparatus is designed to keep them at the desired controlled temperature. By providing two baths it is possible to 'warm-up' the slides in one bath before transferring them to the second bath which will then maintain a constant temperature throughout the timed hydrolysis. After the energy

controller position has been determined and has been set for hydrolysis at 140°F. (60°C.) the baths require approximately two hours to reach this temperature.

Each bath can accommodate up to 10 slides and is supplied with a thick plastic lid that is sunken to prevent spillage of condensation liquid. The lid has an opening for the thermometer that can be closed if desired. This opening can also be used to suspend a small test tube for hydrolysis of small pieces of tissue—the lip of the tube resting on the rim of the opening. A cover glass carrier is supplied that will rest on the bottom of the bath.
(Manufacturers: Electrothermal Engineering Ltd., 270 Neville Road, London, E.7.)

Medium Power Binocular Magnifier

A new series of mountings are now available for use with the Wray binocular magnifier.

This magnifier with its 100x area magnification fills the gap between the single lens and the microscope. The use of a revolutionary type of optical system combines the following features:

Magnification 100x area.
Clear working distance 7 in.
Field of view—$\frac{1}{4}$ in. diameter circle.
No special lighting required.

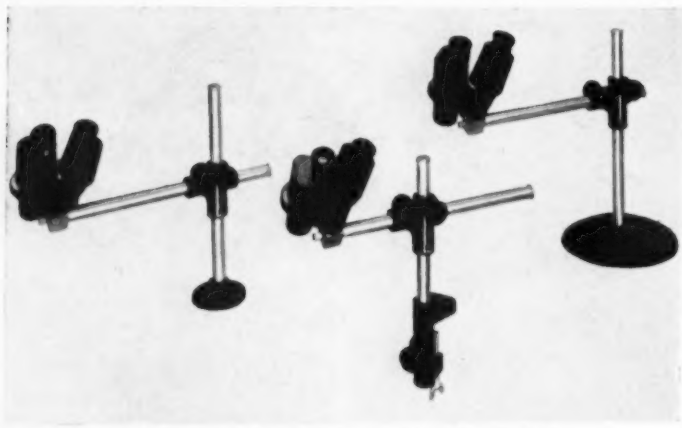
This last great advantage comes with the use of object lenses no less than 1 3/16 in. diameter with their enormous light gathering power.

The magnifier does not require elaborate stands incorporating rack and pinion vertical movements but needs stable and easily adjustable mountings suitable for the large working distance (7 in.) and providing ample clearance for hands and arms when using tools.

The photograph shows the new mounting on three different bases; a universal model with weighted base, a clamp model for desk or bench and a fixed position model.

These mountings and bases are strongly made and finished in satin chrome and non-reflecting black ripple stove enamel.

In addition to the three standard mountings special models using a wide variety of bases, including magnetic and floor stands, are being developed for special applications.
(Manufacturers: P. W. Allen & Co., 253 Liverpool Road, London, N.1.)



Allen stands with medium power binocular magnifier.

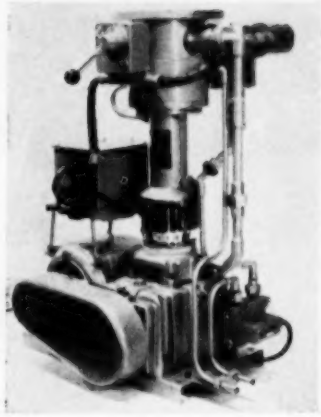
General Purpose Combined Pumping Unit

This unit has been designed to give laboratory staffs and industrial users the advantage of obtaining high vacuum from a fully automatic pumping unit having single lever operation control. It is fully protected against power failure, accidental stoppage or a drop in water pressure.

In the event of accidental stoppage or power failure, the unit is automatically isolated, thus damage cannot be caused to the plant or apparatus in the vessel being evacuated, i.e. if the plant is positioned on fine pump and inadvertently the power supply is cut off, the backing line is closed by a magnetic isolation valve and automatically air is admitted through an air admittance valve, the operation of these two valves being delayed by a two-second dwell in time. This prevents oil being sucked out of the rotary pump into the backing or roughing line.

When the electrical supply is reconnected the air admittance valve closes and a time lag occurs, allowing the backing or roughing line to be pumped down before the isolation valve opens. Consequently the vacuum in the vessel is maintained and hot oil in the diffusion pump does not come into contact with atmosphere.

If the cooling water to the diffusion pump is inadvertently cut off, a red



light indication is given to the operator and the heater to the diffusion pump is automatically shut down.

The operating handle has four positions—rough pump, fine pump, isolation and air admittance—a quadrant movement separating these four positions. When the unit is set on rough pump, the vessel being evacuated is pumped down to approximately 350 microns before fine pump selection occurs, which brings the diffusion pump into circuit; at this setting the rotary pump acts as the backing pump.

The isolation position of the lever isolates both pumps from the vessel and on air admittance a magnetic valve is actuated, permitting air to enter the evacuated vessel.

The unit is now ready for another cycle of operations. It is not necessary to operate the handle in the full cycle of movement since it can be turned clockwise or anti-clockwise through 180° in one movement, i.e. from rough pump to isolation, without harming the unit or apparatus.

This single lever fully automatic pumping unit has been built from standard components and grouped together with the necessary pipework and electrical connections.

Two sizes of unit are available, being designed to give an ultimate of better than 5×10^{-6} mm.Hg., with pumping speed better than 23 litres per second or 100 litres per second, at a pressure of 1×10^{-4} mm.Hg.

The diffusion pumps are of the fractionating type and the backing pumps are gas ballasted to allow the evacuation of chambers containing condensible vapours.

The units may also be supplied with hand controlled valves and without the protection devices applicable in the event of mains or water failure at reduced price.

Liquid air traps are available for both units as optional extras.
(Manufacturers: N.G.N. Electrical Ltd., Avenue Parade, Accrington, Lancs.)

Molecular Models with a Difference

Units from which molecular models, accurate with respect to stereo characteristics, can be quickly built up are produced by the Büchi Company of Switzerland and have recently become available in this country. The units consist of little rods and tubes which are soldered together at the correct angles at a point representing the atomic nucleus; the free ends represent atoms of hydrogen so that the individual units represent CH_4, H_2O, NH_3, etc.

Stereomodels are assembled by introducing the rod of one unit into the tube of another and a push button type of mechanism holds the atoms at the correct internuclear distance (1 cm. represents 0·4Å.) without hindering the free rotation of the rods in the tubes. When two or more atoms are attached to a bond which cannot be rotated under ordinary conditions, they are represented as a single unit; the two principal nuclei are soldered together at the correct distance. A simple system of marking allows easy differentiation between isolated, conjugated, and aromatic double bonds and different atomic nuclei are readily distinguished at a glance by their distinctive colouring.

Büchi stereomodels have a number of advantages. Only the central axes of the bonds are shown and the omission of the electron clouds gives a very clear view of the geometrical relationships and permits easy measurement of internuclear distances. The units are constructed of stainless steel and normal use does not deform them or otherwise wear them out. Stereomodels are small enough for convenient handling and require so little room that a considerable number of units can be carried in the pocket.

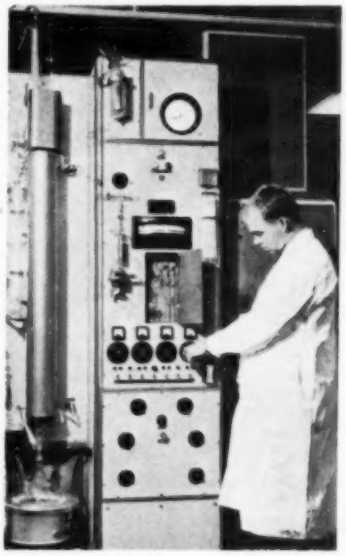
(Sole distributors in Great Britain: L. Light and Co., Ltd., Poyle Estate, Colnbrook, Bucks.)

Laboratory Incubation

A new 'Precision' laboratory incubator maintains the most reliable heating stability within 0·5°C. at 37°C. throughout the cabinet, and at 56°C. the differential is less than 1°C.

Among other developments is the automatic interior lighting, in addition to the spring loaded instrument panel which gives immediate access to the mains voltage setting and for the replacement of bulbs and strip-lights. Of the four shelves supplied (two are 'perforated' and two 'mesh'), the 'mesh' are of particular interest; their construction allows air to circulate freely through the shelves, ensuring a considerable reduction in drying time when the incubator is used for this purpose.

(Manufacturers: Laboratory & Electrical Engineering Co., 71-73 Goldsmith Street, Nottingham.)



Distillation Apparatus

Designed at the Research Centre of the British Petroleum Co., Ltd., Sunbury-on-Thames, the B.P. free standing 14-plate atmospheric and vacuum distillation apparatus was developed originally for the distillation assay of crude oil, but it has proved to be a very versatile unit for a wide range of laboratory distillation work in organic chemistry, and particularly in the petroleum and solvents field.

The main and desirable features in a distillation apparatus are possessed by this unit. They are large capacity, high throughput, ease of control and suitability for operation at both atmospheric and reduced pressures. Light gaseous components can be handled in the liquid phase by circulation of suitable refrigerant in the condenser and receiver system; provision is made for the metering of incondensible gases.

The normal charge to the unit is 4 l., which enables a sufficient quantity of each fraction to be obtained for subsequent analysis and refining treatment. The dimensions of the standard column are 36 mm. internal diameter, 1,370 mm. length and 1,220 mm. packed length, the standard packing being stainless steel boot eyelets which gives a plate efficiency of 14. Alternative packings can be supplied to suit requirements and in special cases to increase considerably the plate efficiency. The column operates under adiabatic conditions.

The apparatus meets the requirements of that recommended by the Institute of Petroleum for the evaluation of crude petroleum (J.I.P., vol. 36, No. 323, November 1950).

In the assay of crude oil it is possible to obtain complete data by means of pilot or semi-scale equipment in which the essential features of the large-scale refinery unit are duplicated. Such methods are, however, costly and most designers of plant prefer a more general type of assay which involves a true boiling point distillation and the preparation of yield data and curves of the significant properties of distillate fractions. The B.P. 14-plate distillation equipment gives a sufficient degree of fractionation to enable this data to be obtained. Narrow boiling fractions can be analysed separately or blended in aliquot proportions to produce a number of possible refinery specification products for analysis, etc., gasolenes, reforming naphthas, white spirits, kerosenes and gas oils. The residue from the distillation can be utilized to prepare a series of residues of differing cut point by back blending with the distillate fractions. Alternatively, the residue can be distilled further in a high vacuum still to obtain lubricating oil and bitumen fractions. Such a subsidiary still is now being developed.

(Manufacturers: Winston Electronics Ltd., Shepperton, Middlesex.)

Variable Power Supply

Type PV-250-B is a versatile and compact unstabilized laboratory power supply, providing a continuously variable d.c. output from 0 to 250 V. at 50 mA., and a fixed a.c. output of 6·3 V. at 1·5 A. for heater supply. Applications include H.T. and bias supply for experimental electronic circuits, bridge energizing, polarizing supply for measurement of electrolytic capacitors, etc.

A switched meter provides three voltage ranges, 0-10 V., 0-50 V., and 0-300 V., permitting the output voltage to be set and read accurately at all levels, and also a current range of 0-50 mA.

For general laboratory use output may be taken from four insulated jack-top terminals on standard ¾ in. spacing mounted on the front. For more permanent connection, the multi-point

socket on the right-hand side of the instrument may be used, a mating plug being provided.

Voltage adjustment is by a special series-valve circuit providing the unique and valuable feature of very high setting accuracy at very low output levels. The output voltage can be adjusted as easily and as accurately at a level of 0·1 V. as at 50 V., with an external voltmeter. The output current can be adjusted smoothly and precisely to any value between 0 and 50 mA., even into a short circuit, so the unit can be used as a variable current supply with the same versatility and precision as when used as a variable voltage supply. Relay setting and adjustment is a typical use for this valuable feature.

The d.c. internal impedance is relatively low on the 250 V. range and high on the 50 V. and 10 V. ranges. The instrument thus tends to approach the ideals of a constant-voltage source at the voltage levels most commonly used for vacuum tube circuits, and a constant-current source at the low voltage levels common in transistor circuits.

(Manufacturers: Claude Lyons Ltd., Valley Works, Ware Road, Hoddesdon, Herts.)

Manual Polarograph

The scope and variety of polarographic work that can be carried out with a manual instrument is not always fully appreciated. The manual method has, however, suffered in the past from two defects—slowness of operation and fatigue to the operator.

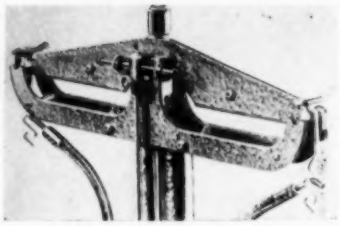
The manual polarograph A.1650 has been designed to overcome both these disadvantages. The 'click stop' adjustment of voltage by exact increments of 100 mV. or 10 mV. in place of a continuously variable slide wire with its attendant troubles, and the use of a fairly short period galvanometer, allows a speed of operation comparable to that obtained with recording instruments. The user has no critical adjustments to make and has only to observe current readings in order to plot polarograms with great accuracy and speed. An analysis can be repeated under identical conditions without precise adjustment and without fatigue. Although provided with the essentials for studying nearly the whole field of polarography, the number of controls has been reduced to a minimum and its simplicity enables it to be operated even by unskilled personnel.

This equipment includes an external galvanometer, but this is optional, as the polarograph can often be used in conjunction with a galvanometer already available, thus bringing the growing science of polarography within the means of even the smaller laboratory. (Manufacturers: Southern Instruments Ltd., Frimley Road, Camberley, Surrey.)

The Griffin 'Minor' Balance

The first of the new series of balances designed for general purposes but incorporating analytical features is known as the Griffin Minor balance.

The Griffin Minor has a short beam for speedier weighing; single-limb bows carry the weighing pans for unimpaired operation, an inclined scale rises with



the pointer, thus facilitating reading and avoiding parallax, a unique design in stirrups protects knife edges, and a new design pillar allows easy and rapid assembly.

The improved assembly of the agate bearings is extremely important because they are held in position by positioning screws instead of being 'drifted in' which is the usual practice. When the beam is arrested *all* the agate bearings are relieved, instead of only the central bearing as is usually the case. This gives much longer life with students and in works control laboratories.

The price in Great Britain is £7. 5s. 0d. (Manufacturers: Griffin & George Ltd., Ealing Road, Alperton, Wembley, Middlesex.)

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

B.D.H. Leaflets.—New entries in the catalogue of British Drug Houses Ltd. of Poole, Dorset, are listed in the January, 1960, issue of their monthly leaflet. These are as follows: *Organic and Inorganic Chemicals.*—Arsenazo; *iso*-ascorbic acid sodium salt; dimethyl digol; 3-phenyl-propionyl chloride; selenium disulphide, and solochrome violet RS.

Heat-Treatment Journal.—The December 1959 issue of the Wild Barfield Heat-Treatment Journal published by Wild-Barfield Electric Furnaces Ltd. (and associated companies) of Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Herts., contains articles on arc furnaces in copper production, a 600 lb. induction furnace and a pit furnace for heat-treating jet engine parts.

Blood Gas Analysis.—A leaflet describing apparatus for the determination of carbon dioxide in plasma and oxygen in blood has been issued by A. Gallenkamp & Co., Ltd., of Sun Street, London, E.C.2.

Marconi Instrumentation.—The December 1959 issue of *Marconi Instrumentation*, published by Marconi Instruments Ltd., of St. Albans, Herts., contains articles on power meters, general purpose oscilloscopes, transistorized voltage standing wave ratio indication and new equipment for impedance measurement at V.H.F.

Construction Kit.—A new brochure from Weyco (Sales) Ltd., 18/20 Dames Road, London, E.7., describes Weyco Fac, the construction system enabling prototypes and machinery to be assembled at minimum cost. Examples of items made with this equipment are illustrated and clearly described.

M & B Laboratory Bulletin.—The February 1960 issue of this Bulletin (Vol. IV, No. 1), published by May & Baker Ltd., Dagenham, Essex, contains Part II in the series Frontiers of Science, Part III in the series University Schools of Chemistry, Part XIV in the series on Laboratory Apparatus and an article entitled Chemistry in the Forest.

Automatic Temperature Control.—A leaflet describing the Jumo-Shandon adjustable contact thermometers has been published by Shandon Scientific Co., Ltd., of 6 Cromwell Place, London, S.W.7. These thermometers with temperature ranges from —59 °C. to +625 °C., provide the ideal solution to the problem of maintaining a constant temperature at a readily adjusted value in water baths, reaction vessels, vats, incubators, drying ovens, sterilizers, distillation apparatus and similar laboratory and process equipment.

Continuous Pipetting.—The Shandon Scientific Co., Ltd., have also issued a leaflet describing the B-D Cornwall continuous pipetting outfits for the fast automatic transfer of accurately measured repeat doses.

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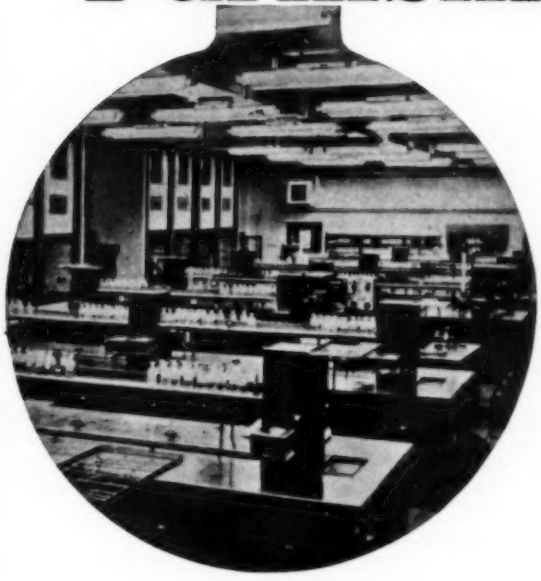

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NEWS

Manufacturers News'

Premier Colloid Mills Ltd. Expands

Premier Colloid Mills Limited of Walton-on-Thames, Surrey, have recently completed the erection of extensions to their main offices and laboratories. These extensions have been planned to centralize the assembly of colloid mills and mixers. Delivery periods have already been considerably shortened and after-sales-service has been speeded up.

Personal Notes

Major General Sir William A. Scott

The directors of Southern Instruments Ltd. announce that Major General Sir William A. Scott, K.C.M.G., C.B., C.B.E., has joined their Board. Sir William was until recently Director of Communications at the Foreign Office and before that was the Director of Weapons and Development at the War Office.

Mr. R. E. F. Sykes

Mr. R. E. F. Sykes, Associate Member of the Institution of Works Managers, has been appointed General Manager of Griffin & George (Laboratory Construction) Ltd., with works at Perry Barr, Birmingham, and Mitcham, Surrey, a subsidiary of the Griffin & George Group.

Mr. Sykes succeeds Mr. A. E. Lambert, who has retired from the company, which manufactures laboratory furniture in wood and metal.

Mr. R. E. F. Sykes

MEETINGS FOR THE MONTH

Mid-April to Mid-May

We give below a selection of meetings of interest to laboratory workers. Details are as full as possible at the time of going to press, but readers requiring further information or confirmation of arrangements should contact the organizers.

April 8

The Society of Instrument Technology (Midlands Section). In the Lecture Theatre of the Byng Kendrick Suite at Gosta Green College of Technology, Aston Street, Birmingham. 7 p.m. Annual General Meeting followed by Debate—'This House Believes that Accuracy Does Not Matter'.

The Chemical Society (St. Andrews and Dundee Section). In the Chemistry Department, St. Salvators College, St. Andrews. 5.15 p.m. 'Nuclear Resonance,' by Dr. R. E. Richards, M.A., F.R.S.

April 13

The Society for Analytical Chemistry (Biological Methods Group). In the Meeting Room of the Chemical Society, Burlington House, London, W.1. 7 p.m. Meeting on 'Hormone Assay in Clinical Practice'. Speakers: J. A. Loraine, M.D., Ch.B., M.R.C.P., Ph.D., and P. H. Wright, M.Sc., M.B., Ch.B.

April 14

The Society of Instrument Technology (Bristol Section). In the University of Bristol, Department of Physics, The Royal Fort, Bristol. 7.30 p.m. Annual General Meeting followed by Film Show.

April 16

The Society of Instrument Technology (Manchester Section). At the 'Manchester Room', Central Library, St. Peter's Square, Manchester, 1. 6.45 p.m. Annual General Meeting followed by 'Instruments in Pharmaceutical Research', by Dr. J. W. Black, M.B., Ch.B.

April 20

The Society of Instrument Technology (Newcastle Section). In The Conference Room, Roadway House, Oxford Street, Newcastle upon Tyne. 7 p.m. 'Gas Calorimetry', by A. D. E. Lauchlan.

The Society of Instrument Technology (Cheltenham Section). At the Belle Vue Hotel, Cheltenham. 7.30 p.m. Annual General Meeting followed by Presidential Address.

April 21

The Society of Instrument Technology (East Midland Section). At the College of Further Education, Greenclose Lane, Loughborough. 6.45 p.m. Annual General Meeting followed by Presidential Address.

April 22

The Chemical Society (St. Andrews and Dundee Section). In the Chemistry Department, St. Salvators College, St. Andrews. 5.15 p.m. 'Are Scientists Literate?', by Mr. John Maddox. Joint Meeting with the University Chemical Society.

April 25

The Chemical Society (Cambridge Section). In the University Chemical Laboratory, Lensfield Road, Cambridge. 5 p.m. 'Some Applications of Mass Spectrometry in Organic Chemistry', by Dr. J. H. Beynon.

April 26

The Society for Analytical Chemistry (Midlands Section). At The University, Birmingham, 3. 6.30 p.m. 'The Analytical Chemistry of Titanium and Zirconium', by W. T. Elwell, F.R.I.C.

April 28

The Chemical Society (North Wales Section). In the Department of Chemistry, University College of North Wales, Bangor. 5.45 p.m. 'Aromatic Fluorocarbon Derivatives', by Prof. J. C. Tatlow, D.Sc., F.R.I.C. Joint Meeting with the University College of North Wales Chemical Society.

The Society of Instrument Technology (Chester Section). At the English Speaking Union, Stanley Palace, Watergate Street, Chester. 7 p.m. Annual General Meeting followed by Film Show.

April 29

The Society for Analytical Chemistry (Scottish Section). At the Central Hotel, Glasgow. 7.15 p.m. 'Chemical Services on British Railways', by G. H. Wyatt, B.Sc., Ph.D.

The Chemical Society (Birmingham Section). In the Large Chemistry Lecture Theatre, The University, Birmingham. 4.30 p.m. 'Halogenation Kinetics of Some Reactive Species', by R. P. Bell, M.A., F.R.S.

May 2

The Chemical Society (Cambridge Section). In the University Chemical Laboratory, Lensfield Road, Cambridge. 5 p.m. 'Acylation and Phosphorylation Mechanisms', by Dr. R. F. Hudson, A.R.C.S., A.R.I.C.

May 5

The Chemical Society (London Section). In the Rooms of the Society, Burlington House, London, W.1. 7.30 p.m. Adolf Windaus Memorial Lecture, by Prof. A. Butenandt.

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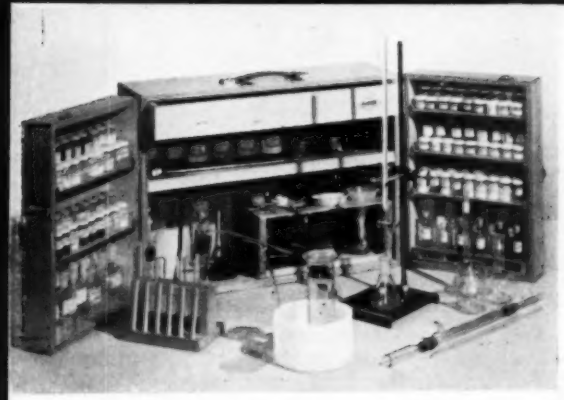

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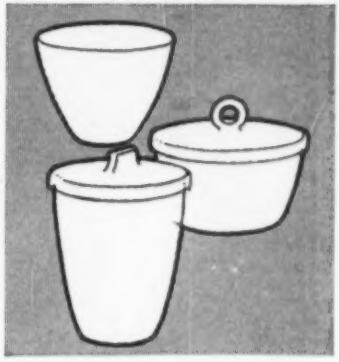

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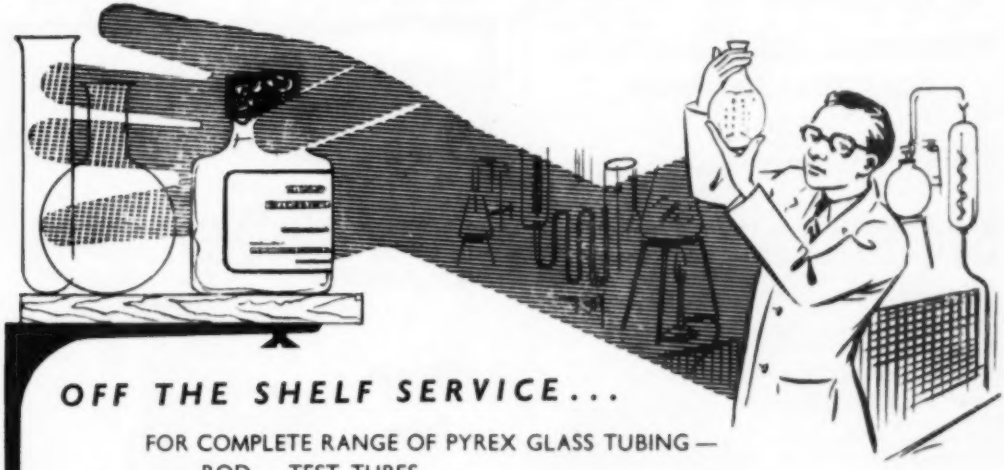

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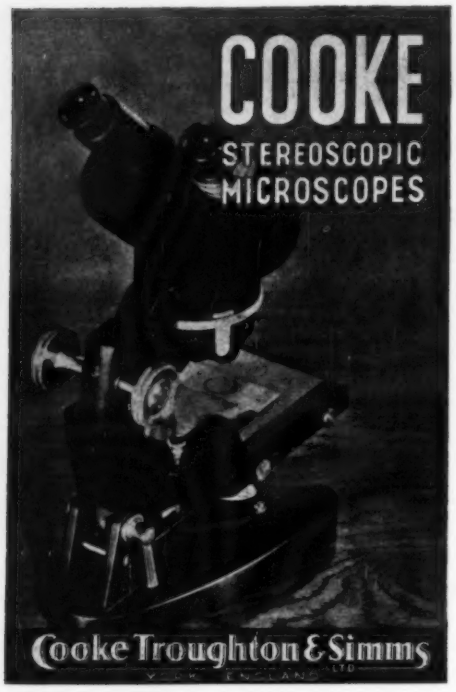

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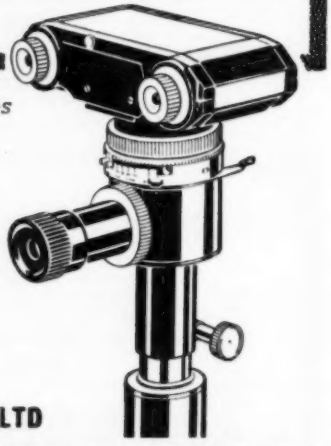

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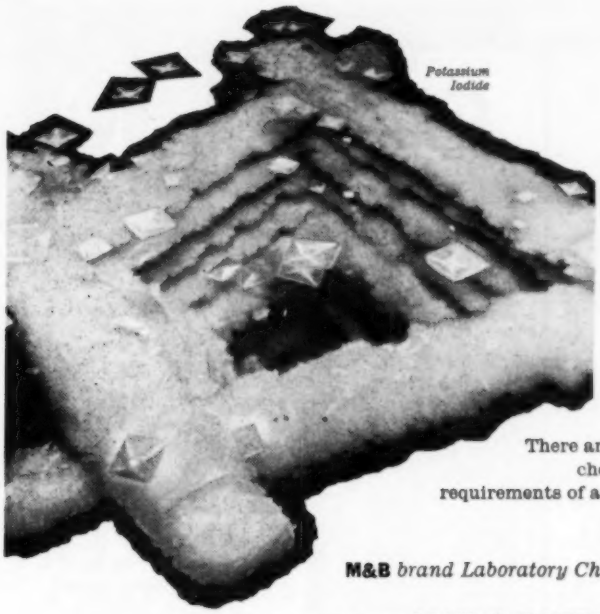

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200	.354	.500	.612	.707	.866	1.06	1.22	1.58
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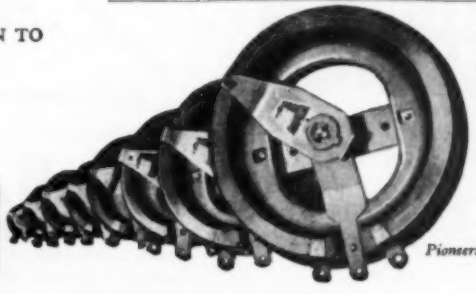

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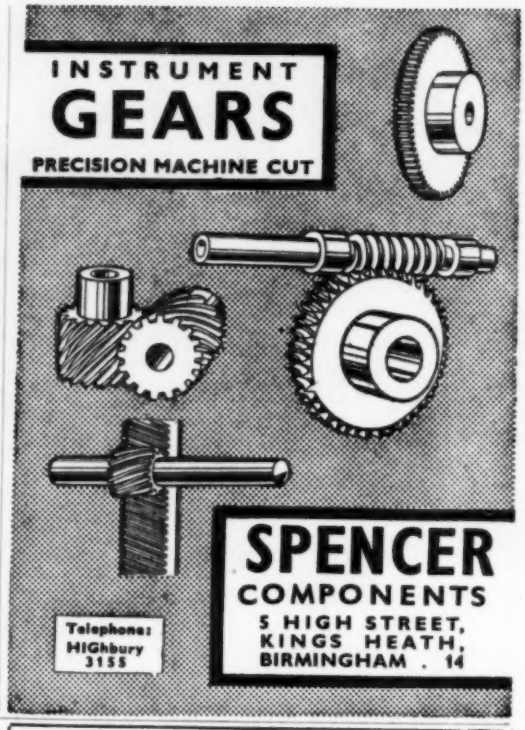

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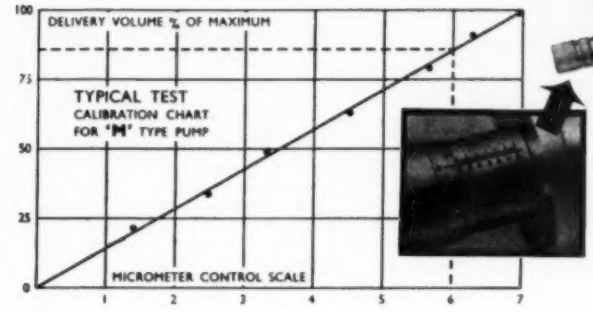

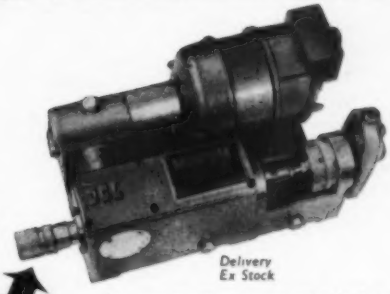

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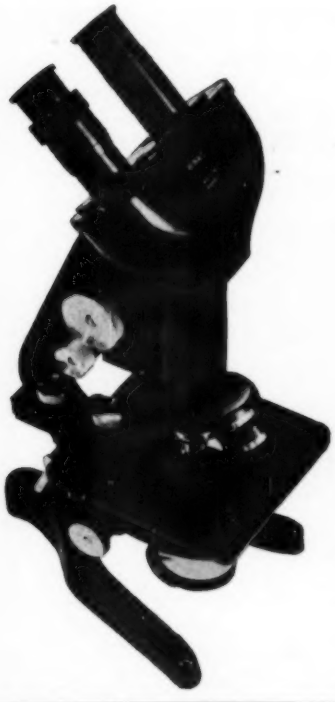

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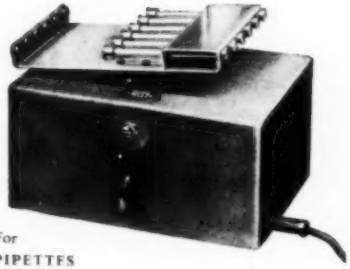

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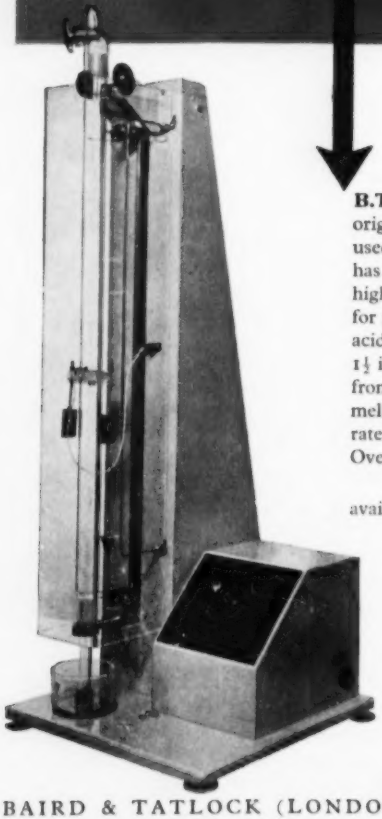

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B.T.L. Zone Melting Apparatus, Macro Model, is developed from the original N.C.L. model and handles quantities of the order of 1kg. It is used for purification of many solid materials, especially organic compounds, and has applications both in laboratory work and small-scale production where very high purity is required. For example, Hopkin & Williams Ltd. use the apparatus for preparation of Benzoic acid P.V.S with a purity of 100·00% from Benzoic acid 'ANALAR' which is over 99·9% pure. The glass melting tube is 3 feet long, 1½ inches diameter, and the length of run is variable. The heater is adjustable from zero to 125 watts and is adjusted to give a molten zone 2° to 3° above the melting point, up to a maximum of 300°C. The heating ring descends at a fixed rate of 1·3 inches per hour, and the melting cycle is repeated automatically. Overall size: 20″ × 20″ × 54″ high. **Catalogue No. C14/500, price £180.0.0.**

A Semi-Micro Model handling quantities up to about 2g. is also available. Cat. No. C14/510, price £47.10.0.

Please send for full details of each model.

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